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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

OCTOBER 13-22.
Motor Exhibition at Olympia, London, W.

OCTOBER 14.
Society of Chemical Industry (Chemical Engineering Group):—Opening meeting in London. "A Recent Development of Spray Drying," Paper by J. Arthur Reavell.
Institution of Engineering Inspection:—First meeting of the session in London. Paper by C. M. Read on "Electric Power Cables and Recent Developments."

OCTOBER 18.
Institution of Engineers and Shipbuilders in Scotland:—General meeting at Glasgow. "British Engineering Export Problems," Paper by William S. Murphy.

OCTOBER 19.
The Newcomen Society for the Study of the History of Engineering and Technology:—Ordinary general meeting in London.

OCTOBER 20.
Institute of Metals (Birmingham Local Section):—"Isotopes." Paper by Dr. F. W. Aston, M.A., F.R.S.

OCTOBER 22 NOVEMBER 13.
Berlin Conference on Engineering Materials.

Preserving the Broad View.

The modern trend towards an even higher degree of specialisation is admirably illustrated by the annual welter of conferences from which we have just emerged, and the greater number of which have been, after all, conferences or meetings of specialists or of specialised interests.

Specialisation in one form or another is becoming more and more essential in industrial life to-day. This is largely because with the enormous advance in technical and theoretical knowledge it is practically impossible for any one person or organisation to cover more than a strictly limited field, if, that is to say, it is to be covered adequately and with due regard for the up-to-date and efficient. Furthermore, the requirements that have to be met become daily more complicated and exacting, and they demand an extremely high degree of specialisation both in the work and in those who control it.

This tendency has great inherent dangers, and in many cases they are already more than inherent. The specialist is in very grave danger of losing contact with the whole of his concentration on the part. What matters to him is not the finished article, but the screw or bolt that he spends his life producing, not the firm but his own process in it, not the industry but his own sales, not the prosperity of the country but the volume of complaints he receives. The specialist loses touch, and he is consequently in danger of losing balance. He spends so large a part of his life and his energy on some small process or field that it assumes an utterly disproportionate importance, and he tends to become both dogmatic and unreasonable.

The essential is for the specialist to retain the broad view, to preserve the perspective of the wood as a whole in spite of his preoccupation with the trees. It is a thing that few specialists are able to do, but those who can are invaluable.

The conference season—for such indeed it has become of late years—has two sides. There are the conferences that are the annual meetings of highly-specialised societies of specialists who are in constant touch with each other and meet on such occasions primarily, it would appear, to find out where they differ. The Institute of Metals, the Iron and Steel Institute, and others of this type, are excellent examples of these. And there are conferences of the other type which are no more than meeting grounds for people—probably just as specialist in their way—who have some one point in common and no more, and whose ways never cross from one year's end to another outside the four walls of the conference. And these meet rather to discuss points of agreement. The recent Business Management Conference in Rome was an excellent example of this, as was in actual fact the Shipping Exhibition at Olympia, although in a slightly different fashion. The mechanism is much the same in either case. A suitable site for discussions is provided, together with a topic to set the ball rolling, and a quite invaluable social atmosphere. But there in reality the likeness ends. Each has its part to play, but in assessing the achievements of this year's conferences and in determining the rival attractions of those that are to come, it is essential to bear in mind this distinction—that the one type fosters the specialising tendency, while the other works against it.

Each is necessary. Specialisation is the breath of life to-day, but specialisation without the broad view is suicidal.

Selling Castings Abroad.

Whilst the major portion of the products of the foundry are built up into other articles and so lose their identity, not an inconsiderable quantity is exported virtually in their virgin condition. Pipes and light castings are outstanding examples. Orders are received from time to time from customers abroad who are practically unknown to the supplier. As the average foundry owner enters a bank with a demeanour analogous to a student visiting a pawnbroker's establishment for the first time, such conditions are not conducive to a request for a credit necessary to cover wages and material essential for execution of an overseas order with the possible result of a bad debt. If, on the other hand, he could get his insurance company to cover him for 75 per cent. of the risk, he could face his bank manager with some assurance. The new export credit scheme of the Department of Overseas Trade provides him with these facilities. They have a sort of capital of over £20,000,000 for this purpose, and no risk is too big or too small. Additionally they have probably the finest debt-collecting agency in the world. We specially commend this scheme to the cast-iron pipe manufacturers to be studied in connection with the South American markets, for there one finds the anomalous situation that one country buys wholly from Britain, another wholly from Germany, a third mainly from France, whilst a fourth is divided between the exporting countries. If the solution lies in the giving of credit, then the remedy is to hand, but rapid action is necessary, as other countries so admire this new export scheme that they are emulating the British example and will in the near future accord similar facilities to their nationals. The details of the scheme are the essence of simplicity, and the only reservations made are the obvious ones, such as an exception in the case of the export of munitions of war, and that the material to be exported must be British. We strongly advise all foundry owners to acquaint themselves with this scheme, either by inquiry to their local Chamber of Commerce, their bank, or the Department of Overseas Trade, London, S.W.1.

That the Foundries of the United States are using more and more fluor spar is borne out by the fact that 5.52 per cent. of the American output is now being used in foundries, as against 4.35 per cent. in 1921.

XUM

The Lining of a Cupola.*

By Frank Russell, F.G.S.

This Paper makes no pretentions to be a scientific discourse, for so much has been said about refractories for use in iron foundries that it is very difficult for an author to break new ground.

There has been a remarkable absence of anything in the shape of literature on refractories from the people who make them; truly remarkable, because so many steel manufacturers, for instance, do not hesitate to talk about their products. The reason why the makers of refractories do not emulate them is because they are afraid that they may be suspected of advertising their own goods, or, further, accused of decrying the products of their competitors. It is obvious, therefore, that any author must proceed very warily in dealing with the subject chosen.

So many things have been said and have been left unsaid about cupola linings, and there have been so many half-truths and biased statements, hints, suggestions, and suppressions, that it is very difficult to get at the naked truth.

The alternative methods of lining a cupola are divisible into two main branches: (1) Bricking and patching, and (2) ramming, *i.e.*, the production of a monolithic lining.

Composite Linings.

Composite linings such as those made with firebrick and subsequently patched with another material may be condemned off-hand by many people as being inferior to one-piece or monolithic linings, but the principal defect of a firebrick lining is that in 99 cases out of 100 it is made of ill-fitting bricks, which need wide joints. These joints are filled with a soft, weak fireclay, which does not set until the heat is applied, which cannot stand the blast or the atmosphere of the cupola, nor even the heat, and consequently slags away, leaving an open space between the bricks. This enables the destructive actions to operate on the sharp edges of the bricks, with the result that each joint rapidly becomes a hollow space, with consequent ultimate destruction of the brick, unless it is quickly patched. Experiments which have been made have led the author to the conclusion—and this is stated without any bias one way or the other, for he is interested equally in monolithic and brick linings—that if a brick be close grained, and has the proper mechanical texture, and is bonded with the correct bonding medium, always provided that the brick is of excellent shape so that the surfaces may fit closely, then a brick lining is as good as any clay lining. There seems to be no good reason why a brick made of selected clay, carefully burned, should not be equally as good for every practical purpose as a lining made of unburned clay.

Running through the alternative methods, first there are firebricks alone, patched, when worn, with ground ganister. They can also be patched with clay or a sandy clay, and they can also be patched if desired with a clayey sand. These terms are used in preference to the names of certain proprietary products. The founder can also consider a rammed lining of clay or sandy clay, a rammed lining of clayey sand, a rammed lining of sand such as the Gornal sand of Staffordshire. The last-named lining is used extensively in Birmingham and the Black Country by the bedstead makers. There is also a rammed lining of Derbyshire white ganister sand, and a rammed lining of "ground ganister"—a name used to cover a multitude of mixtures which have only one thing in common, and that is that they are all ground. Additionally, the founder may consider a lining of silica bricks, such as those used with some success in certain parts of the United States, and the author is definitely of opinion that a properly made and properly burned silica brick in a cupola from which very heavy service is expected can be relied upon to yield very satisfactory results. It is necessary, however, that that silica brick shall be specially burned to resist the forces which will otherwise very quickly destroy it. To order merely a silica brick for a cupola would be useless; it must be specially selected and specially burned for a cupola lining.

Mica Schist.

Then there are other linings which visitors find in the United States, some of which make them glad and some sorry, but mostly sorry—for instance, those which utilise mica schist. Mica schist is a mineral of slaty texture; it chips off into flattish plates. It is a mineral constituted of silica and alumina, with a good deal of alkaline matter in it, and in some foundries in the United States the British visitors found it used in the form of thin plates almost like firebrick splits, perhaps ½ in. or 1 in. thick. The surface of the cupola was made sticky with fireclay, and the piece of mica schist was pressed into place, afterwards being luted round the edges with more fireclay. In some foundries it was found that the cupola lining was composed of what was thought to be an unholy mixture of old sand, a common kind of fireclay, and this mica schist, all ground up in a mill together. This, however, is not so bad as it seems, because many of the foundries there use a sand which is exceedingly coarse, containing as it does a large number of quartz pebbles, which serve as a reinforcement. Thus the results are not so bad as one would expect, although they are far from what we in this country would consider good. Founders can leave mica schist out of their calculations, because so far, though there is plenty of mica schists in this country, no one has yet been able to discover any which have the same physical, chemical and refractory properties as the mica schists of the United States.

What is Ground Ganister?

With regard to the lining with firebricks alone, patched, when worn, with ground ganister, there is a very important point not properly understood by many iron founders. If ground ganister is to be made to stick easily to the side of a cupola, it must contain so large a proportion of sticky fireclay and must be ground so finely that a great deal of its refractory quality is lost. Continually suppliers receive inquiries and orders for finely-ground ganister, it not being understood that the mere fact that when ganister is finely ground with a fireclay, means that at the same time one is just destroying those very qualities sought after. Ganister is a highly siliceous rock found in the coal measures, as the underlying bed below a certain seam of coal, known as the "Halifax Hard Bed." Above and below this particular bed of what one might properly call best ganister are numerous other beds of an inferior stone, which is easily obtained, sometimes by quarrying, and is very much less expensive than best ganister. It should be emphasised that it is very easy for ground ganister suppliers to reduce its cost to themselves by adding these inferior stones, and particularly by adding various other siliceous rocks which are very common indeed in the Sheffield district, such, for instance, as the moorland grit stones, which, although quite high in silica content, do not possess the peculiar quality which distinguishes best ganister rock from any other rock in any part of the world the author has yet visited.

Patching with Clayey Materials.

For the method of patching the worn firebricks with either clay or sandy clay it is easy to make the clay stick, but in any case it is too fine in the grain to be highly refractory. As to the third method, that of patching with clayey sand, it is not easy to make it stick, but even if you do make it stick it is not coarse enough to be highly refractory. The author is therefore driven to the conclusion, after many years of experiment and experience, that on the whole the best way to line a cupola is by ramming round its walls a monolithic lining. He has in mind a cupola with a 4½-in. thick lining which has not been renewed for ten years. During that period the walls of the cupola have been coated with a rammed lining. It is fairly clear, however, that such ramming material must be highly refractory, which means siliceous, if one is considering cheap materials, and must at the same time be coarse, as otherwise there is a great tendency for the surface to be glazed and for the material behind it to be in the form of a soft powder, particularly if that material contains a large percentage of clay. This is because the heat of the cupola drives the combined water from the clay, which in any case shrinks, so that it has not been uncommon for the glazed surface to be penetrated and for something in the nature of a hollow to be found behind it.

Ramming a Cupola.

Undoubtedly the proper way to line a cupola is to prepare a wooden plug in two halves which fit together and form a cylinder the size of the orifice it is desired to leave in the centre of the cupola. This plug should be rested on the cupola bottom, the lining material should be pitched down to a man who is standing on the top of the plug, and he, with a rammer, should ram it tight down the space between the plug and the cupola shell. He should not ram too much at a time; about 4 ins., or, at any rate, 5 ins., is quite enough. When this ramming has reached the top of the plug it should be hauled up a few feet higher by means of a chain passing through a ring at the top of the plug and over a pulley at the top of the cupola. It is easy to fix this pulley on a plank and to haul by means of a small windlass in a convenient position. This ramming and raising is continued until the charging hole is reached, when the man steps out, hauls the plug a little higher, takes the two halves apart, and brings them out of the charging hole. The lining should then be very carefully dried out with a slow fire. In the case of sandy clays and clay, this drying is by no means easy, and if it is to be done effectively so that the best results are obtainable from the lining, it must be performed with the greatest possible care. It is also necessary to prick a large number of vent holes in the lining, so as to permit the steam to escape from the back portion of the lining through the close and somewhat leathery material. When all these precautions have been taken, and the lining of sandy clay has been dried perfectly, one is only exposing to the action of the destructive agents a fireclay containing a certain amount of silica sand. These two materials are so closely intermingled that they tend to reduce each other's refractory value. Scientific investigators state that materials in a fine state of sub-division cannot and do not resist heat so well as those which expose larger volumes to the action of the heat and fluxes. Certain clays have the advantage of setting mechanically hard. They ram very closely and firmly, but this latter virtue becomes a defect in another way, because it means that longer drying time is necessary, and venting is essential if steam is not to be trapped between the shell and the outer portion of the lining, resulting in expansion when the cupola is heated up, and the blowing off of a portion of the lining.

Similar remarks apply to clayey sands, except that these materials do not set so hard and dense. They are much more sandy than the material previously dealt with. It is thought that they come from the Eisenberg district of Germany, but it is difficult to see why this country need send to Germany for refractories of that or any other class for the lining of cupolas. It is within the author's personal knowledge that there exist in this country large deposits of clayey sands which are just as suitable for lining cupolas as any imported material he has yet been privileged to inspect. Clayey sand does not need venting, but, on the other hand, it never possesses the same mechanical strength as clay or sandy clay. It is easily removed by abrasion, though from the standpoint of resisting heat pure and simple it is possibly rather more refractory than clay or sandy clay.

* A Paper presented last Thursday at the London Branch of the Institute of British Foundrymen, Mr. W. B. Lake presiding. The author is a past president of the Refractories Association and the Managing Director of the General Refractories Company, Limited.

Gornal Sands.

The Gornal sand can be dismissed as having the same faults and causing the same difficulties as the clayey sand, but the Gornal sand or any other clayey sand does not set so easily or so readily as the clay or sandy clay. No venting at all is necessary. It is easily removed by rubbing, and in order to get good results it is essential that a fierce heat shall glaze over its surface. If it be mixed with a little fireclay it sets harder but is less refractory, and in any case it has the same defects as its two predecessors in that it is in such a fine state of sub-division that it is physically unable to withstand a very high temperature.

Derbyshire White Ganister.

Derbyshire white ganister sand is a useful material largely in favour with the malleable iron founders in Walsall. Nevertheless, all that has been said about sands and clayey sands apply equally well to the Derbyshire white ganister sand, with the exception that it varies so much from time to time and from place to place. In one place in Derbyshire it might contain 94 per cent. of silica, and in another place 88 per cent.; sometimes it contains stones and sometimes it does not. There is no guarantee that it will always be the same, and therefore the man who uses it must vary his procedure in regard to lining from time to time in accordance with the quality of the material he happens to receive. The author has suffered a good deal whilst selling this material during the past ten years.

Ganister Linings.

The best types of linings, in the author's estimation, are those which contain lumps—comparatively large lumps—of a heat-resisting material of siliceous nature, as, for instance, lump ganister, though it is not suggested that the lump ganister is the only form of silica which will give satisfactory results. One is continually hearing comparisons made between ganister and certain refractory clays. It is obviously unfair to contrast a rammed lining of any kind with a lining consisting of worn firebricks patched here and there with ganister. One does not hear comparisons made between rammed ganister linings and rammed clay or rammed sand linings, but rather comparisons made between cupolas which are patched with these materials and others which are rammed with other materials. It has already been stated that for patching with a ganister one must reduce its refractoriness by grinding quite finely and adding clay. The patching ganister is not of the same quality as the ramming ganister, as something of its refractory nature must be sacrificed to make the former stick to the walls of the cupola. Given that great rarity, a supply of really high-grade ganister rock, assuming it being crushed in lumps from 2½-in. down to powder and mixed with the very least possible quantity of the stickiest and most adhesive fireclay obtainable, assume thorough mixing, so that each grain and lump of the rock is coated with the binder, add to this the very minimum quantity of water, and intelligent ramming, it gives a lining which:—(1) Dries quickly; (2) sets quite hard; (3) needs no venting; and (4) contains lumps refractory enough to resist any commercial heat whatsoever.

These lumps act as a reinforcement to the mass, in the same way as the aggregate in concrete acts as a reinforcement when each portion of it is coated with cement. They prevent the finer grains of ganister and the fireclay from fusing away. The fireclay dries and sets the lumps fixed firmly in their position with the aid of the powdered portion of the ganister, the result being a hard, cohesive mass which will in most cases stand in the cupola nearly twice as long as any other lining obtainable. Strength is given to this opinion by the knowledge that firms who have in the past advocated the use of rammed clay linings now advocate the addition to the clay of silica or quartzite or ganister in large lumps.

Ganister a Variable Commodity.

A word of warning is necessary that it is very difficult to obtain this class of ganister; even in Sheffield for those who know the business it is not too easy to obtain a supply of the purest and best original ganister rock, on account of the demand for it for silica brick making. It cannot be bought cheaply. It is not a matter of price at all, but of quality, when considering a rammed lining of this type. Nothing is easier than to reduce the quality of ground ganister in order to knock a shilling or two off the price. The best and most refractory ganister rocks are scarce, difficult to obtain, and command a high price amongst those who really know. There are, nevertheless, vast quantities of second and third grade rock obtainable, and nothing is easier than to grind these up with a cheap fireclay and to send the resulting product out to the foundry industry as "Sheffield Ground Ganister."

A Standardised Article.

Ganister is like charity—it covers a multitude of sins—and foundrymen should wash some of it under the tap in a tumbler and see what remains in the bottom of the glass when the flow of water has removed the fireclay. What foundrymen require is a standard grade of ground ganister in which the rock should be guaranteed as being of a certain degree of hardness and a certain refractoriness. This should be mixed with a standard quality of clay to a specified extent only, and a certain limited quantity of water should be added. Two mixtures should be made, one for patching and one for ramming, and no wise foundryman should attempt to cut either quality or price. It will pay him to pay a fair price for a good article, and the sooner this is realised the better for the trade in general. The Refractories Department of Sheffield University has undertaken research into the whole subject of ground ganister for lining cupolas, and now, after having made their experiments, which were of a most exhaustive character, it is engaged in preparing the details for a standard mixture which ultimately will be something which any foundryman will be able to rely upon and which he will simply order or specify as "standard quality." It will be agreed that this is a move in the right direction.

It has often occurred to the author that firms or manufacturers of cupola linings might undertake the upkeep of the cupola linings on the basis of a fixed payment per ton of metal passed through the cupolas, in the same way that some furnace builders contract to repair open-hearth furnaces for a payment of a fixed sum per ton of steel produced.

Summary.

The best way to line a cupola may be summed up by stating that (1) monolithic linings are the best; (2) they should consist of a mixture of hard, comparatively large refractory lumps with a most refractory clay or other satisfactory binding medium. They should be carefully applied, carefully dried and carefully used. Comparative figures analysing the cost per ton of metal produced will show that without the slightest doubt there is no real comparison between a lining so made and one made by the ordinary haphazard catch-as-catch-can methods of lining with bricks and subsequently mending it from time to time with one of the many substances outlined.

Finally, it would be interesting to learn whether anyone in charge of a cupola has considered the advisability of insulating that cupola against heat losses. So much important work has been done and so much saving has been shown in the cases of kilns, ovens and furnaces that it might be very well worth while making a cupola larger in order to make room for, say, a full 4½-in. course of insulating bricks in order to reduce the heat losses, which certainly occur now to a very considerable and perhaps unsuspected extent.

Discussion.

The Branch-President, expressing gratitude to Mr. Russell for his admirable lecture, said he had done what so many other speakers did not do, he had got to the heart of the problem and had told his hearers in detail what he thought was best, whereas so many others had dealt only with the scientific side, and practical foundrymen had listened in vain for any real particulars such as Mr. Russell had given.

Mr. T. H. Gray asked, somewhat pointedly, whether Mr. Russell had ever rammed a cupola himself, or whether he was talking from what he had heard. (Laughter.)

Mr. V. C. Faulkner questioned whether the provision of a set of insulating bricks was worth while for a cupola. The idea in an insulating brick, he said, was simply one of imprisoning air; it was the air which was unable to move about which gave it good insulating properties. One could effect that particular object, however, by several means. In the first place, an air space between the bricks and the ironwork was reasonably effective. A second method was to leave a space and fill it with kieselguhr, or even rubble would do, so long as there was imprisoned air, and he did not consider it necessary to buy expensive insulating bricks. These useful bricks consisted of fireclay which had been mixed up with cork during its manufacture, and during the burning the cork burned out and left air spaces.

Mr. Russell, replying, said he had much pleasure in informing Mr. Gray that he had never yet rammed a cupola. He had always felt that his time was too valuable, and had every confidence in those who, like Mr. Gray, had actual experience of ramming. (Laughter.) The insulating brick to which he had referred at the conclusion of the lecture was not the one Mr. Faulkner had in mind, but one which was actually made of kieselguhr, and it insulated in a manner different from that of a fireclay brick containing air spaces. He did not suggest, however, that bricks were necessary. It was quite conceivable that 2 in. or 3 in. of rammed kieselguhr or diatomite, which was siliceous earth containing diatoms, which latter contained air in such infinitesimal quantities that that air could not move, might give very satisfactory results as an insulator. He was certain that it would give results as good as those which could be achieved by the use of bricks. There was a vast loss of heat through the walls of cupolas. In this connection he instanced the case of a firm who were burning lime in a cupola 10 ft. in diameter; they had built up an interior lining, so reducing the diameter to 4 ft. 3 in., filled up the intervening space with various materials which had an insulating effect, and had found that the fuel consumption in that particular insulated cupola was 3, as compared with 4½ in the case of a cupola of corresponding size and with the same interior diameter, but with a lining of only 9 in. of firebrick. That, said Mr. Russell, might give food for thought.

Contracts Open.

Johannesburg, October 27.—50 tram poles, for the Stores Department, Town Council of Johannesburg. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 5,258.)

London, S.E.1, October 18.—(1) 40 steel crank axles for locomotives, for the India Store Department, Branch No. 14, Belvedere Road, Lambeth, S.E.1. (Fee 5s. per set, non-returnable.)

London, S.W.1, October 18-24.—(1) 1,270 axleboxes for carriages and wagons (cast steel or malleable cast iron); (2) girder bridge spans of 6, 12 and 20 ft. (an approximate total tonnage of 155), for the Madras and Southern Mahratta Railway Company, Limited, 25, Buckingham Palace Road, Westminster, S.W.1. (Fee £1 1s. each, non-returnable.) Tenders due October 18 for (1) and October 24 for (2).

Plymouth, October 27.—6,000 yds. of 4-in. cast-iron pipes, British Standard, Class D, for the Plymouth Corporation Waterworks. The Town Clerk, Municipal Buildings, Plymouth.

Stockport, October 17.—(1) Mild steel shafting; (2) mild steel paddle wheels (9-ft. diam.); (3) miscellaneous works, for the Sewage Outfall Committee. Mr. H. Hamer, borough surveyor, Town Hall, Stockport. (Fee £1 1s., returnable.)

Teignmouth, October 24.—14-in. diam. cast-iron gas main, water-tube condenser, rotary washer scrubber, station meter, three-lift gasholder and Lancashire boiler, for the Urban District Council. Mr. H. Higham, gas engineer and manager, at Teignmouth.

Wigston Magna.—Cast-iron street lamp columns and lanterns complete, for the Urban District Council. Mr. W. G. J. Clark, engineer and surveyor, Wigston Magna.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Rammed Linings.

To the Editor of The Foundry Trade Journal.

Sir,—I have read "Ceramicus's" letter with interest, and as evidently he is a great (but modest) scientist, I will not attempt to query his theories, but will rest content knowing that whatever the reason may be a rammed lining does give extra efficiency.

Replying to your other correspondents. Peg rammers are employed and they are usually heated to a bright red; not for any scientific reason, but for the common-sense one of keeping them hot as long as possible when in use.

Iron bricks are quite unnecessary in a hand-charged cupola, but where that so-called labour-saving device, a mechanical charger, is used it is advisable to have them in, and they should be carried sufficiently far down the shaft to assure they will always receive the full force of the charges.

The material suggested is not ganister, but a special preparation.

What is one man's food is another's poison. The same applies to rammed linings, and I suggest your Grimsby correspondent gets in touch with a foundry where a rammed lining is installed (and there are many), and then try one out for himself.—Yours, etc.,

The Author.

October 10.

Random Shots.

We all know that there is no rest for the wicked, but seemingly the conscientious are in much the same pair of shoes. No sooner have we taken off our boots and settled down to a season of slippered ease over our own fireside o' nights than we are bombarded with announcements of forthcoming events, and Conscience begins to get busy again. The Machine Tool and Engineering Exhibition is announced to take place at Olympia from September 5 to 22 next year; Newcastle-on-Tyne offers us a North-East Coast Exhibition from May to October in 1929, while Sydney, New South Wales, is already planning a British Empire Exhibition, to which, no doubt, some of us will inevitably be drawn, so far ahead as 1931. A hard life. . . .

* * *

Lifting magnets are to be used in salving the pig-iron cargo of the s.s. *Elterwater*, which lies on the rocks in the Firth of Forth. How our historic seamen would turn in their graves at the thought! Although it is to be feared that even lifting magnets would not be very much help in rescuing the Spanish gold and the "ivory and apes and peacocks" that went to the bottom in their day. . . .

* * *

It was reported not long ago that a foundry, dating from between 300 and 400 B.C., had been discovered by quarrymen in the volcanic Eifel district of the Rhineland. A certain distinguished Rhineland professor of our acquaintance, visiting this country only a short time before the announcement in question was made, was loud in his praises of this very Eifel district, and, sad to relate, Marksman was driven to his atlas to seek particulars. Everyone is well aware of the beauties of the Black Forest and of the Rhine itself, but it was only the subsequent arrival of a very fine collection of views of the district that established "Die Eifel" as a rival. . . . But it would assuredly be interesting to hear a little more about a foundry flourishing in so remote a period of time. . . .

* * *

Our Correspondence Page.

(*With Apologies to Certain Twopenny Weeklies.*)

Send all your Troubles to Uncle Algernon: He will Feel for You like Your Own Foreman!

A. B. (Scotland).—I can, of course, understand what a handicap it must be to you in the foundry that the odour of alcohol has such a violent effect upon you. No, I do not know of any cure for this type of nausea, and can only counsel you to persevere, since ultimate success in your chosen profession depends so largely on your overcoming this handicap.

C. D. (Wales).—If you will send me a stamped addressed envelope I can let you have the name of a handbook that will, I think, help you in your present difficulty. It was, indeed, a pity that your mother did not bear in mind your firm determination to take up ironfounding as a career when she brought you up so carefully and guarded you from all knowledge of strong language. . . .

E. F. (Yorkshire).—No, I do not think that you will find the foundry the best place in the world to meet the charming young ladies for whose society you feel so great a need. The average employer does not, as a rule, encourage his daughters to visit him during business hours, nor do I think that your foreman would be any more amenable to suggestion on this point. I cannot help feeling that if, as you say, "Life without the fair sex is no life at all to me," you would do better in some other walk of life—say, as a shop assistant. . . . In the meantime, why not join some nice social club, or make friends with those of your fellow-apprentices who have sisters?

Marksman.

THE LANCASTRIAN SOCIETY.

The Lancastrian Society, or the "Club Lancastria," as it is known on the Continent, is made up of foundrymen who crossed to America on the "S.S. Lancastria." This photograph was taken during the Paris Convention, on the steps of M. Montupet's house.

Front Row:—Mr. F. Russell; M. Montupet (France); Mrs. Russell; M. Vanzetti (Italy); M. Brons (Holland). *Second Row*:—M. Magdenat (France); M. Galtarossa (Italy); Mr. Primrose (Falkirk); M. Ropsy (Belgium); M. Vanzetti, Jnr. *Back Row*:—M. Montupet, Junr.; M. Primet (France) and M. Primet, Jnr.

Foundry Query.

Cold and Hard Iron.

We are meeting with considerable difficulty in making metallic bedsteads here. Our furnace is a small one, 19 ins. dia. inside, which we have reduced to 12 in. to try and get better results.

Our chief trouble is that we are not able to get the iron at a uniform temperature, in most instances it is not hot enough for our work—chill castings.

We use No. 3 foundry pig-iron, and 50 per cent. scrap with each charge. The furnace melts quickly enough (sometimes too quickly), but we do not seem to be able to get the iron hot enough.

Again, if we make a sand casting we find that it is too hard for machining.

Redmond & Company.

Swift's Alley, Dublin.

[Please send a sketch of your furnace, which we presume to be a cupola, together with coke ratio, blast arrangements, type of iron scrap used, etc.—Editor.]

Notes from Germany.

On September 23 Dr. Helmuth Peters, attached to the administrative staff of the German Foundry Owners' Federation, died of yellow fever at Accra (Gold Coast) shortly before the date on which he intended to return to his home at Düsseldorf.

Herren Oberingenieur Neufang, of Köln-Mülheim, and Dr. Rudeloff, of Berlin-Dahlein, who celebrate their 70th birthdays on October 17 and 23 respectively, are to be awarded with the highest honour that the Foundry Owners' Federation can bestow, that of the Siegfried Werner Medal.

The Metallurgist and the Founder.

The Lancashire Branch of the I.B.F. began the 1927-28 session with a meeting held in the Manchester College of Technology, on Saturday, October 1, at which Mr. J. S. G. Primrose, A.R.T.C., A.I.M.M., delivered his presidential address, in the course of which he said:—

Mr. Smith and Gentlemen.—In the first place I desire to express to you my very sincere appreciation of the honour you have done me in calling upon me to fill the position of President to your important branch of the Institute. During the time I have been associated with it, it has been my privilege to be on the active list of a number of the other live branches, and in each of these the experiment has on several occasions been proved successful of having a metallurgist to fill the presidential chair, and as I appear to be the first member of that profession to be selected in your branch I shall do my utmost to maintain the high level of achievement elsewhere, and moreover try to emulate the loyal service rendered in your interests by my noteworthy predecessors here. I fully realise that in this high endeavour I cannot stand alone, but by the loyal co-operation of the branch council, and your support as expressed by regular attendance at the meetings, I feel every confidence that we can go forward to a session of good and useful work in the progress of our art as foundrymen.

In view of the experiment with which we are opening this session, in presenting a film of a practical foundry operation for your edification, it is not proposed to give you such an extended review of progress as we had at this time last year, but I would like briefly to draw your attention to what may be considered a side line, but nevertheless a very important one, the services which metallurgy has rendered to the foundryman in the improvement of his every-day practice. The study of metallurgy in itself may be called a science embracing the knowledge of the principles of the production and properties of the chief raw materials used in the foundry, but the practical application of this knowledge is an art in many ways comparable to the art of founding itself, and from which, indeed, many of its earliest lessons were learned. In its broadest aspect the aid of metallurgy to the practical man has been chiefly in the scientific arrangement and discussion of useful data which has enabled him to proceed along sensible lines of action in cases of emergency, instead of letting him follow the old plan of groping for a remedy on the hit-or-miss principle. More than anything else, the influence of metallurgy has been to keep the worker in the casting of metals abreast of the means of meeting the changes in working conditions from which are demanded results that must ever meet more severe inspection and tests if they are to conform to the constantly increasing exacting nature of the requirements of the main engineering and allied trades. Only in such a way can the products of the foundry hope to enter into the ever widening spheres of usefulness which lie before them in the march of modern progress.

Teaching to Ask.

Metallurgy has been able to place at the disposal of the foundryman a vital force of which he has not been slow to avail himself in order to improve the importance of his position as a purchaser, and the time has now passed away in which he had to depend to a large extent upon taking from his suppliers a great proportion of the material which was of inferior quality from the point of view of more influential buyers, such as the steel makers. Now when a founder knows what he wants, he can definitely ask for it and ensure that he gets it, a matter of which he could not make sure without the aid of the metallurgist. It is now no longer necessary to lay the blame of unexpected occurrences in the foundry upon bad metal. There should be no bad metal even among the so-called inferior qualities. They have their uses, and the chief mistake lies in trying to apply them to purposes for which they are unsuited. This axiom applies equally to other raw materials and even to machinery, and the many applications of mechanical devices which have been brought into use in the foundry to lighten tasks and assist in easy production.

Metallurgy the Servant.

The proper sphere of metallurgy in the foundry is that of a guide, counsellor and friend, for it is often found to be disparaged when its advocates attempt to place it in the arrogant position of a master with a strong dictatorial voice, instead of that of a useful servant, just like the fire it so frequently uses in its practices. Metallurgy is really a means to an end, and not the end itself, and it has, therefore, to call upon many allied subjects to its own aid, such as chemistry to enable composition to be arrived at, physics and mechanics to determine strengths and properties, and, finally, the microscope and X-ray apparatus to find out the constitution of the materials it has to deal with. Electricity is pressed into its service also to provide the necessary power to perform such varied operations as lighting, heating, melting and purifying the products of and for the foundry, and as greater familiarity is achieved in handling this effective power, we shall see wonderful changes when the heat and other effects we desire to produce can be generated inside and not outside the material. Electric steel and alloys are now commonplace in our foundries, but the day of commonly-produced electric iron is still to come.

The watchword which metallurgy has instilled into the foundryman is surely "Test, and test again." No sooner has perfection been achieved in some direction which has been the outcome of diligent research, not necessarily of an academical, but often of a purely practical character, when changed conditions bring about the need for further developments. Then must all the resources of mechanical tests and chemical tests be brought to bear, and the more arduous task of correctly interpreting the results of these be called into force, and finally the application of the findings must be brought down to a practical issue before further success can be achieved and new laurels won.

Alloyed Cast Iron.

One of the most promising outlets for the aid of metallurgy in the foundry at present would seem to be the more successful application of the knowledge already partly completed in bringing about a new era of high-duty alloy cast irons. Already very noteworthy practical results have been achieved by thermal methods of control of the ordinary and special composition irons, but even more promising results are already appearing from the extended use of the commoner alloying elements such as nickel, chromium and tungsten. When this metal is next subjected to what might appear as elaborate heat treatment, the resulting product would hardly be correctly termed cast iron, and yet we are merely on the threshold of wide and important developments in this direction, for improving the vital properties of strength and toughness in wear. Experimenters all over the world are working with the very best available machines and apparatus to give us the results of their experiences, and even if we cannot get directly in touch with them for ourselves it behoves us all to support the British research associations which bring to us the valuable results of others as well as their own achievements, which will aid in keeping our home practice abreast of that of our competitors abroad, and in some cases of enabling it to forge ahead through the application of the technical skill of our foundrymen who need fear no rivals, provided they are well and truly guided.

Mr. S. Smith (the retiring President) said a great deal of matter had been compressed into the address to which they had just listened, and the time was too short to allow them to go into the points which were touched on. Everyone present acknowledged the usefulness and even necessity of the metallurgist's work, and agreed that it would be a good thing if he worked hand in hand with the man who was responsible for turning out the castings. Reference had been made to alloys. He was reminded of a phrase he used himself about twelve months ago, that an alloy was a voyage of discovery.

Mr. T. Makemson, in proposing a vote of thanks to Mr. Primrose for the address, said they were much in his debt for having directed attention to the advantages of co-operation between the metallurgist and the practical foundryman.

The necessity for such co-operation was realised by the members of the Lancashire Branch, and they felt the time had come when the presidential chair should be occupied by a metallurgist. In some quarters there might remain a certain amount of prejudice, but any criticism which might be put forward had been anticipated by Mr. Primrose in pointing out that the metallurgist was a good servant but not necessarily a master.

Mr. A. L. Key seconded the vote of thanks. He emphasised the observations regarding co-operation. The metallurgist had a more extensive knowledge of his subject and had studied more deeply the technicalities than the foundryman, who was concerned with carrying out the operations, and in the ordinary way his work was regarded as being on a somewhat higher plane. But about some aspects of it, he was quite as much in the dark as the ordinary foundryman. He could and did assist to a great extent, but in order that progress might be made it was essential he should work in conjunction with the practical man.

The vote of thanks was carried unanimously.

Mr. W. West, of Leyland, gave a lecture upon "Motor Cylinder Castings," which was illustrated by lantern slides and a cinema film showing how the operations are carried out.

Institute of British Foundrymen.

SHEFFIELD BRANCH.

The first meeting of the 1927-8 Session was held on September 30 in the Albany Hotel, when Mr. Ambrose Firth delivered his Presidential Address, the subject being, "Progress in the Foundry." He said that up to comparatively recent years the foundry was a very much neglected branch of industry, but more recently great progress had been made, especially in the introduction of mechanical aids to the foundry worker. There was danger, however, in the excessive use of mechanical apparatus, which gave less scope for the skill of the individual. A good moulder was a very highly skilled workman, whose existence should not be jeopardised, and the repetition production of moulds by apprentices at piece-work rates tended to give quantity, not quality. It was important to encourage the individual's interest and pride in his work. Continental and British practice were compared.

During the discussion, in which Messrs. Hyde, Pollard, Batty, Barker and Capt. Dibden took part, attention was drawn to the fact that mechanical aids which were not employed to their full capacity might prove very expensive owing to their standing charges, and that in some cases expenses for replacements and repair were heavy, as the sand in the foundry found its way into parts of machines where its presence gave much trouble.

The Council of the Institute of Metals has just issued the 1927-28 programme of the Institute and of its local sections in Birmingham, Glasgow, London, Newcastle-on-Tyne, Sheffield and Swansea. Over 30 papers are enumerated; these cover such practical subjects as brass-foundry practice, permanent mould casting in aluminium alloys, special alloys in relation to the corrosion problem, gases in metals, with particular reference to copper, and some metallurgical problems of the electrical industry. The commencement of the 1927-28 session coincides with the opening of new offices of the Institute and of an additional library and reading room at 36, Victoria Street, London, S.W.1.

Institute of British Foundrymen.

LANCASHIRE BRANCH: Junior Section.

This Section held its first meeting of the session last Saturday, at the Manchester College of Technology, and Mr. T. Makemson delivered his presidential address. It was preceded by the presentation of the "John Wilkinson" medal, presented by Mr. J. Thewlis Johnston, of Manchester, which was competed for in May last and was won by Mr. S. B. Poole, of Whitefield.

The Chairman said this was the third year in which the medal had been competed for and won. On the second occasion there were a large number of competitors, but the standard of the work was inferior to that in the previous year. In May last there was a falling off in the number of candidates, but the quality of the work improved: generally the Papers were of a good class. For the institution of the competition credit must be given to Mr. J. S. G. Primrose, and he had laboured, more than anybody else, to make it a success. Therefore, it was fitting that the presentation of the prizes should be made by him.

Mr. Primrose said on previous occasions reference had been made to the life and work of John Wilkinson, in whose memory this medal was given. His successes had been spoken of. Perhaps, also, a useful lesson could be learned from his failures. But really very little was known about his doings. One interesting thing was the manner in which his partnership with his brother was dissolved. It was agreed between them that the machinery should be broken up and smashed with sledge hammers, and an equal division then made between them. To many people that would seem an extraordinary way of dealing with the machinery, but it was not adopted without some reason. Both men were stubborn and obstinate, and if the division between them had been made on the basis of a valuation of the machinery there would have been risks of disputes and consequent litigation in the law courts which would have been far more disastrous than the loss involved in reducing the machinery to scrap metal. In fact, litigation did come later. A lawsuit was begun by a nephew of John Wilkinson which went through the Court of Chancery, judgment being eventually given in favour of the family.

Mr. Primrose then presented the prizes, the list of winners being as follows:—*First Prize* (Medal): S. B. Poole, of Whitefield; *Second Prize* (Book): J. E. Garside; and *Highly Commended*: A. Burgess, H. Harrison, H. Hodgetts, H. Nichols.

The Chairman said the Section began with a very large membership, and it was anticipated that the numbers would not be maintained. Those who attended the meetings and took an active interest in the work of the Section would remain, but others would fall away. That had happened. Of course, also, as time went on the Section necessarily lost members who had profited by the opportunities it offered to qualify themselves for education on a higher level. It was now the business of the members to build up again an enthusiastic Section; they could do this by bringing in those who were associated with them in their work. Let each one try to introduce a fresh member in the course of the session. He strongly advised them also to take advantage of the classes in foundry subjects which had been established by the educational authorities in Manchester and other Lancashire towns.

Foundry and Drawing Office.

Mr. W. Jolley occupied the chair while the presidential address was delivered. Mr. Makemson took as his subject, "The Work of the Foundryman in Relation to the Drawing Office." He said machinery of all kinds was becoming more complicated, and the foundryman had to adapt himself to new conditions and find a way of producing the difficult shapes which were now necessary. The general design was more important than his convenience, and he could not expect the designer to think only of the difficulties which would have to be overcome in casting. But he should be allowed to make suggestions. His experience would make them valuable, and if practicable they ought to be given effect to. Often a slight alteration in a design would make all the difference between a casting which was difficult or almost impossible to obtain soundly, and one which was comparatively easy to make.

Mr. Makemson gave examples, illustrated by sketches and lantern slides, of cases where the nature of the design caused difficulties which would be almost, if not entirely, eliminated by the adoption of changes which he pointed out. One method by which engineers sought to reduce the cost of machining was to make as many parts as possible in one casting, thus reducing the number of joints which had to be machined and bolted together. It was a praiseworthy motive, but the effect was to add enormously to the troubles in the foundry. As an illustration, he showed a cast-iron pipe with a bend which could be divided into two simple castings, much more easily set up than one complicated casting. So, also, the casting of two steam-engine cylinders separately, to be afterwards bolted together, involved little extra cost in fitting and machining, while moulding was simplified and the risk of setting up internal stresses was much lessened.

Probably more trouble was given to the founder by unequal sections and abrupt changes in thickness than by any other matter connected with design, and often the remedy was easy. Another cause of complaint was that the machine shop was too exacting in regard to the accuracy required in the castings. From the engineer's point of view accuracy enabled the cost to be kept down, because the amount of work in the machine shop was reduced. In repetition work, accuracy and uniformity were necessary to enable the castings to be inserted in jigs. Closely allied with the question of accuracy was the amount of machining allowance. It should be as small as possible consistent with obtaining a clean surface. The patternmaker who left "plenty on" for machining might add considerably to the machining cost. On the other hand the engineer must understand there was a limit to the accuracy that could be reasonably expected in a rough casting.

A vote of thanks to Mr. Makemson for his address was passed unanimously on the motion of Mr. Yeoman, seconded by Mr. J. Yates.

Mr. Jolley said the address raised many points which were likely to provoke discussion, and were perhaps put forward for that purpose. Certainly the engineer's point of view had to be considered, and to cast in two or three pieces instead of in one would mean enormous cost in the machine shop. The patternmaker ought to keep in mind that the object was to produce a right casting. Sometimes when the casting was wrong the patternmaker insisted that the pattern was right, and he was disinclined to amend it; he required to be told that if necessary the pattern must be wrong in order that the casting might be right.

Mr. Makemson said he did not suggest that castings generally should be reduced to its simple parts and those cast separately. Each case had to be considered on its merits, balancing the reduction in the cost of machining against the risk of trouble in the foundry. Often it was advisable to spend a little extra in one department in order to avoid risk in the other.

Mr. Garside asked for information regarding the way of getting over the trouble arising from unequal sections.

Mr. Makemson said he thought there was not much difficulty in getting the designer to deal with those parts. Most draughtsmen were amenable to persuasion. The use of chills or denseners was often an effective remedy, but it was much more satisfactory to alter the design so as to eliminate the thick part if that could be done.

Mr. Miles described cases in his own experience where difficulties had been overcome on the lines suggested by Mr. Makemson, by obtaining a more equal section of metal.

Mr. S. G. Smith said in a great many cases there was now co-ordination between the drawing office and the foundry. Designs were altered on the representations from the latter, though not always willingly. He suggested that matters would be simplified and expense saved if a pencil drawing or sketch of a new design was submitted to the foundry before the job was proceeded with.

An Appreciation from Germany.

Dr. Siegfried G. Werner, for many years the president of the German Foundry Owners' Federations writes us:—"Bei dieser Gelegenheit möchte ich Ihnen gern mein Kompliment machen über die Entwicklung des Foundry Trade Journal im letzten Jahre. Ich glaube, dass Ihre Zeitschrift heute den Anspruch darauf machen kann, eins der best redigierten Fachblätter der Welt zu sein," which translated reads:—

I should like to avail myself of this opportunity to pay you a compliment in respect of the development of The Foundry Trade Journal last year. I think your journal may now claim, that it is one of the best edited technical papers in the world.

South Wales Foundrymen's Social Evening.

The Wales and Monmouth Branch of the Institute of British Foundrymen opened their Winter Session on Saturday last with a smoking-concert at the Grand Hotel, Cardiff.

The guests were welcomed by the Branch-President, Mr. Ben Hird, of Newport, who acted as host, and he emphasised the importance of the work of the Institute, urging all present to take a more active interest in the forthcoming lectures and the work of the Institute in general.

Mr. J. T. Goodwin, of Chesterfield (President of the Institute), also attended, giving a very interesting address, which included some of his recent experiences abroad. In referring to trade conditions, he expressed himself as optimistic for the future in this country.

Mr. McLelland, the hon. secretary, arranged a most enjoyable musical programme, which included the following artistes:—Mrs. Ethel Rawden, Messrs. W. Morton, J. Morgan, T. Wild, F. Pearson and H. Thomas.

A Correction.

Mr. M. L. Becker informs us that in his discussion on Professor Hanson's recent Paper concerning the Constitution of Silicon-Carbon-Iron Alloys, read and discussed before the Iron and Steel Institute in Glasgow, two errors appear in our issue of October 6 on page 9. In column 1, lines 15 and 17, the words "rate of pressure" appear in place of "vapour pressure," whilst in column 2, line 7, the word "graphite" should read "cementite."

At a meeting of the London Branch of the Institute of British Foundrymen, held at the Engineers' Club, last Thursday, Mr. W. B. Lake, the Branch-President, presented to Mr. H. C. Dews the Institute's Diploma, awarded to him by the General Council for his Paper on "Contraction and Alloy Casting," read at the joint meeting of the Branch and the London local section of the Institute of Metals in December, 1926.

A Spoilt Advertiser's Announcement.—The advertisement of Messrs. Pittevil & Company, of 9, Bush Lane, Cannon Street, London, E.C.4, in our last issue was somewhat spoilt by a clerical error in the instructions received by our advertisement department. The message should have read: "Buy British and Be Proud of It.—The motor trade was subjected to an intensive sales propaganda along these lines. The inevitable result of false values is the swing (not saving as printed) in the opposite direction."

The Influence of Nickel and Silicon on an Iron-Carbon Alloy.*

By Arthur B. Everest, Ph.D.; T. Henry Turner, M.Sc.; and Professor D. Hanson, D.Sc. (Birmingham).

Within the past few decades the development of steels has been very considerable, but during the same period the other large class of iron alloys, the cast irons, has been relatively little improved. It cannot, perhaps, be expected that the same degree of success will be achieved with cast irons, of which the properties are so largely influenced by the presence of graphite, as with the steels, yet it would be surprising if the application of the same methods as have been used for alloy steels should not have important effects in the cast irons. The question is one of considerable importance, since there is an urgent demand for improved properties—mechanical, chemical, and magnetic—in these materials.

Numerous attempts to improve cast irons by alloy additions have been made, with some success in all of these directions, but the advances already made are only of such a character as to lead to the belief that much more can be accomplished.

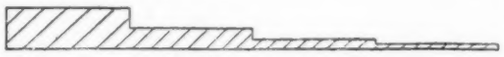

Fig. 1.—Form of Step Bar Casting.

American washed iron, of which the following is a typical analysis, was used as the basis of these experiments:—Total carbon, 3.7 per cent.; graphite, trace; silicon, 0.03; sulphur, 0.03; phosphorus, 0.016 per cent.; manganese, nil. Silicon was added as metallic silicon of 97 per cent. purity.

For adding nickel a special alloy was used. This is a proprietary article, prepared in the form of shot, containing, in addition to nickel, some silicon, iron, and carbon, and known commercially as "F" shot. It has a melting point about 200 deg. C. lower than that of pure nickel, and is fluid

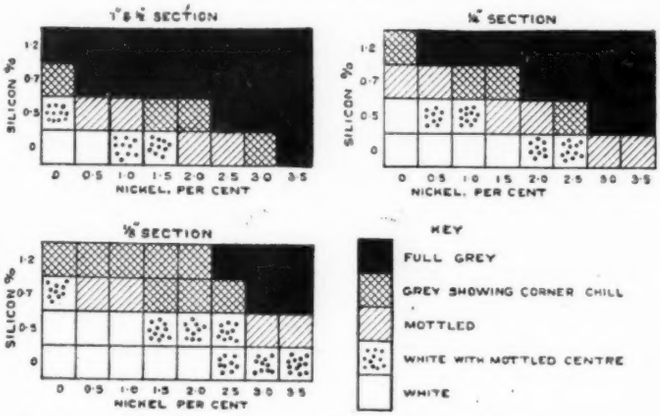

Fig. 2.—Effect of Nickel and Silicon on Iron-Carbon Alloy Fractures.

* Read before the Autumn Meeting of the Iron and Steel Institute.

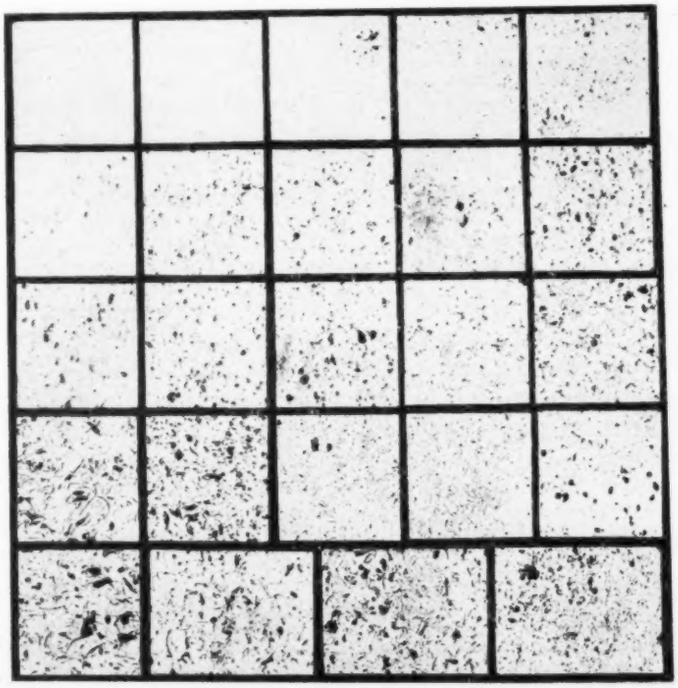

Fig. 6.—Effect of Nickel and Silicon on Graphite. (× 20.)

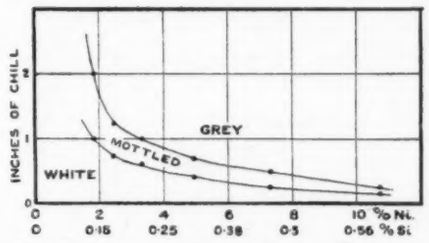

Fig. 3.—Depth of Chill. Initial Silicon: Nil.

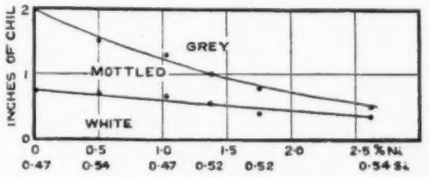

Fig. 4.—Depth of Chill. Initial Silicon: 0.5 per cent.

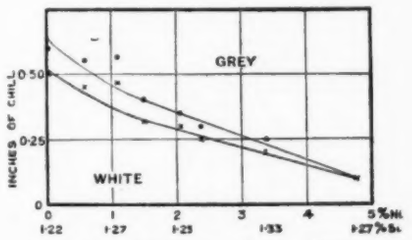

Fig. 5.—Depth of Chill. Initial Silicon: 1.2 per cent.

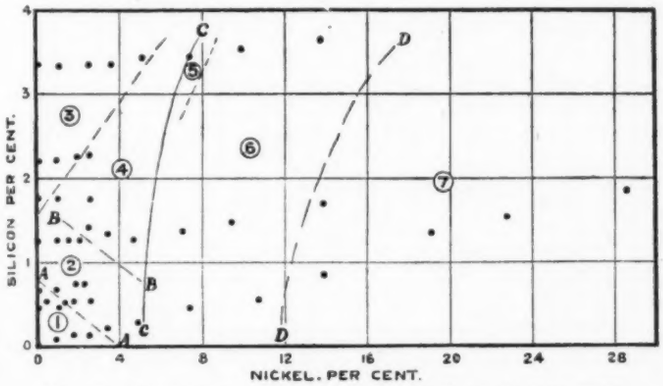

Fig. 7.—Constitution of Nickel-Silicon-Iron Alloys with 3.5 per cent. Carbon. As Cast, 1-in. Section.

(1) Pearlite + austenite-cementite eutectic; (2) pearlite + pro-eutectoid cementite + graphite; (3) pearlite + graphite; (4) sorbite + graphite; (5) martensite + graphite; (6) martensite + austenite + graphite; and (7) austenite + graphite.

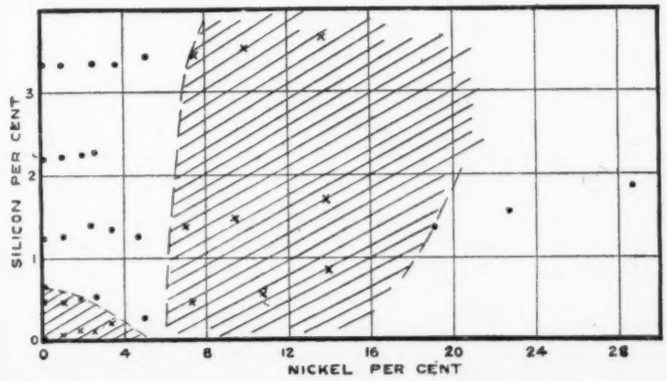

Fig. 8.—Machinability of Alloys as Cast. Shaded Areas Correspond to Alloys not Readily Machinable.

at the normal casting temperatures used for cast iron and similar alloys; it is therefore a particularly suitable form of nickel for adding to iron-carbon-silicon alloys. The approximate analysis of the "F" shot is given as:—Nickel, 91.75 per cent.; silicon, 5.75; iron, 1.85; carbon, 0.3 per cent.

The alloys tested by the authors were as follows:—(*a*) Low-nickel alloys, corresponding to cast irons with small additions of nickel. Nickel additions from 0 to 2.5 per cent. were made at 0.5 per cent. intervals to alloys made up of washed iron with silicon added at intervals from 0 to 3.5 per cent. (*b*) High-nickel alloys, made up by adding nickel at intervals from 3.5 to 15 per cent. to alloys containing initially 0, 1.2, and 3.3 per cent. of silicon, and at intervals from 15 to 40 per cent. to low-silicon iron.

Experimental Method.

Form of Test.—Two castings were made from each alloy investigated:—(1) A step bar casting (Fig. 1) having four steps each 3 in. long × 1½ in. wide, the steps being 1 in., ½ in., ¼ in., and ⅛ in. thick, this being cast in green-sand moulds previously skin dried, and having the flat face 12-in. × 1½-in. uppermost. The metal was run from the side into the 1-in. step, a small riser being taken off the tip of the ⅛-in. step. This form of casting was selected as giving information concerning the fluidity of the metal, the degree of chill obtained in the small sections, and the influence of thickness of section on the hardness and other properties. (2) A bar 1¼ in. wide × ⅝-in. thick × 3½ in. long cast on end in green-sand on to a heavy cast-iron chill, 3½ in. dia. × 1¾ in. thick.

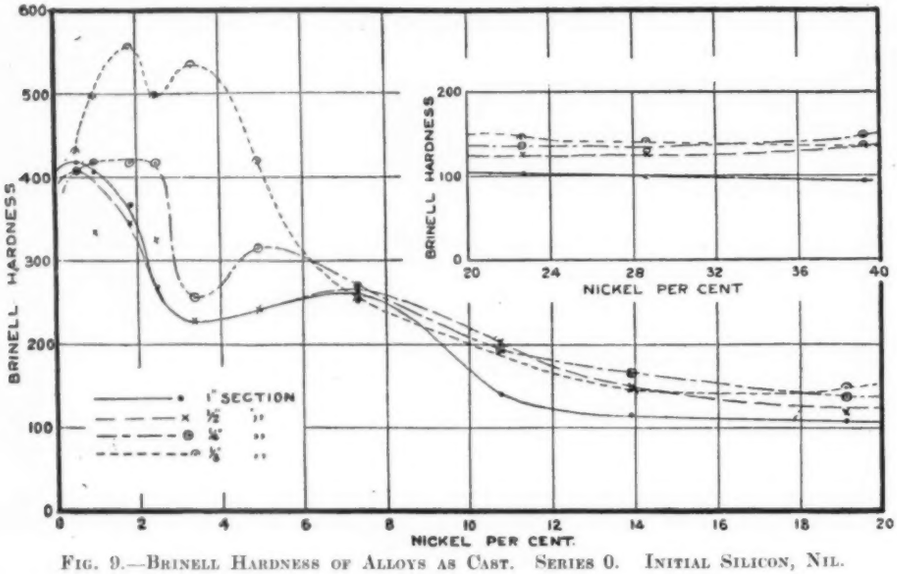

Fig. 9.—Brinell Hardness of Alloys as Cast. Series 0. Initial Silicon, Nil.

Experimental Results.

Analyses of Castings.—Where the alloys were machinable, drillings for analysis were taken in each case from the 1-in. step. Samples crushed in a percussion mortar were taken from the ½-in. step when the iron was too hard to drill. In Tables I to V the balance of the elements not recorded averaged sulphur, 0.03; phosphorus, 0.02 per cent.; and manganese nil.

The influence of nickel in graphitising white iron is brought out in the first tests in Tables I and II; however, except in the case of the high-silicon alloys (Table V), the amount of carbon graphitised became almost constant at between 50 and 65 per cent., and remained between these limits on additions of nickel up to 20 per cent. Where the iron had already been rendered completely grey by its initial silicon content, small additions of nickel appeared to have little effect on the state of combination of the carbon (see Tables IV, V). Silicon was, in general, almost constant with small additions of nickel, and showed a tendency to rise somewhat on larger additions of nickel, owing to the silicon content of the "F" shot. The total carbon fell appreciably on the addition of higher percentages of nickel.

Appearance of Castings.—Except for the first four tests in Series 0, all castings took a sharp impression of the mould. The metal showed no lack of fluidity even with the largest nickel additions, and the ⅛-in. step of the casting was run successfully, provided the pouring temperature of the iron was not below 1,250 deg. C., which is a low limit. The skin of the castings was good. With high nickel additions (over 10 per cent.) the skin tended to become silvery white, very smooth and almost shiny, where the iron was chilled at all.

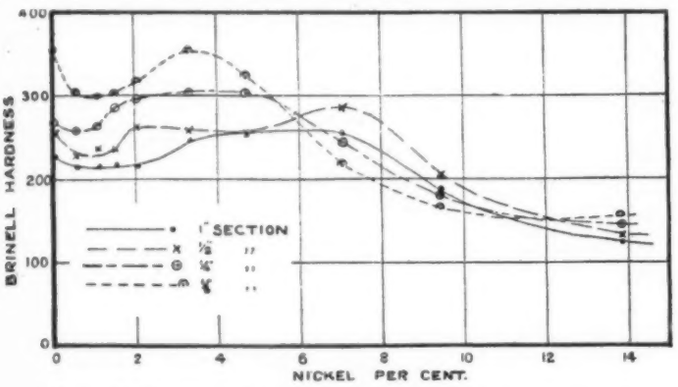

Fig. 10.—Brinell Hardness of Alloys as Cast. Series 2 and 4. Initial Silicon, 1.2 per cent.

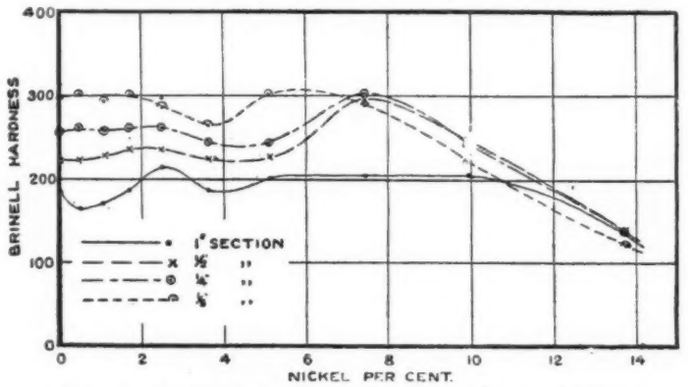

Fig. 11.—Brinell Hardness of Alloys as Cast. Series 6. Initial Silicon, 3.3 per cent.

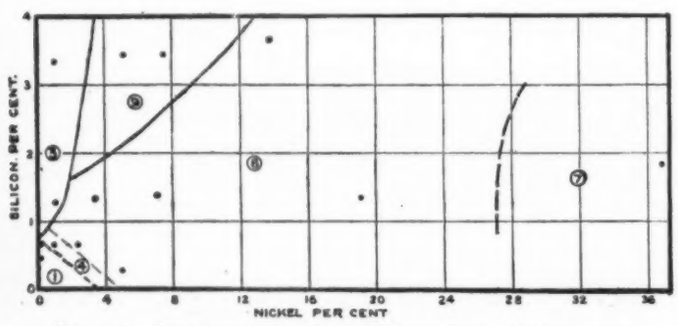

Fig. 12.—Structure of Nickel-Silicon-Iron Alloys with 3.5 per cent. Carbon. Annealed at 650 deg. C. for Six Hours and Cooled Slowly in Furnace.

(1) Pearlite + austenite-cementite eutectic; (3) pearlite + graphite; (4) sorbite + graphite; (7) austenite + graphite; (8) granular pearlite + graphite; and (9) ferrite + graphite.

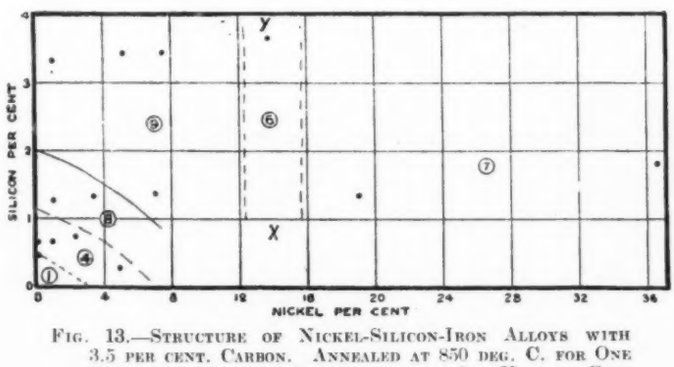

Fig. 13.—Structure of Nickel-Silicon-Iron Alloys with 3.5 per cent. Carbon. Annealed at 850 deg. C. for One Hour and Cooled in Furnace, taking One Hour to Cool to 650 deg. C.

(1) Pearlite + austenite-cementite eutectic; (4) sorbite + graphite; (6) martensite; (7) austenite + graphite; (8) granular pearlite + graphite; and (9) ferrite + graphite.

Table I.—*Initial Silicon added, Nil.*

Test No.	00	02	04	05	06	07	08	09	010	011	012	013	014
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Comb. carbon	3.60	3.57	1.73	1.57	1.57	1.55	1.36	1.33	1.26	1.01	0.91	0.68	0.30
Graph. carbon	0.03	0.02	1.82	1.85	1.98	1.90	1.82	1.77	1.75	1.82	1.82	1.82	1.81
Silicon ..	0.01	0.07	0.16	0.14	0.21	0.29	0.47	0.56	0.85	1.35	1.53	1.86	2.58
Nickel ..	Trace	0.59	1.81	2.44	3.36	4.91	7.31	10.75	13.90	19.10	22.80	28.57	39.22

The first tests in Series 0, with very low silicon, and small additions of nickel showed the effects of sluggish metal; the ½-in. step was not properly run in any case, and all the corners and edges in the castings were rounded, giving the castings a baggy appearance. The addition of 1.5 per cent.

Table II.—*Initial Silicon, 0.5 per Cent.*

Test No.	10	11	12	13	14	15
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Comb. carbon	2.21	1.64	1.48	1.43	1.48	1.35
Graph. carbon	1.47	1.96	2.14	2.15	2.14	2.18
Silicon ..	0.47	0.54	0.47	0.52	0.52	0.54
Nickel ..	Trace	0.50	1.03	1.38	1.75	2.62

of nickel gave a sharp casting, but the metal still appeared somewhat sluggish on pouring.

Fracture and Chill.—The bars cast on to the chill blocks were broken longitudinally, and the nature of the metal and degree of chill were noted.

Table III.—*Initial Silicon, 1.25 per Cent.*

Test No.	40	41	42	43	44	45	26	27	28	29	210
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Comb. carbon..	1.60	1.43	1.32	1.44	1.29	1.46	1.48	1.55	1.38	1.44	1.19
Graph. carbon	1.92	1.96	2.01	2.02	2.04	1.99	1.67	1.65	1.70	1.51	1.62
Silicon ..	1.22	1.25	1.27	1.25	1.25	1.40	1.33	1.27	1.39	1.48	1.70
Nickel ..	Trace	0.59	1.10	1.53	2.06	2.38	3.38	4.77	7.08	9.44	13.85

Table IV.—*Initial Silicon, 2.2 per Cent.*

Test No.	50	51	52	53	54	55
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Comb. carbon	1.34	1.22	1.30	1.22	1.19	1.19
Graph. carbon	2.28	2.28	2.26	2.20	2.22	2.30
Silicon ..	2.20	2.27	2.22	2.26	2.25	2.29
Nickel ..	Trace	0.51	0.98	1.46	1.97	2.54

The influence of nickel on the original iron is illustrated in Fig. 14. This shows the fractures across the middle of the ½-in. step of the castings containing increasing amounts of nickel. Initially the iron was completely white and unsound; on adding 0.5 and 1 per cent. of nickel, it was rendered gradually more sound, and was almost completely sound on the addition of 1.5 per cent. of nickel. At this percentage of nickel there were a few specks of grey iron in the centre of the fracture. Further additions of nickel rendered the iron more mottled, and finally it became completely grey on the addition of 4 per cent. of nickel. Thus the influence of nickel on this iron is seen to be similar to that of silicon, but its action was much more feeble in rendering the iron first sound, then grey. In general, to produce a given effect, four times as much nickel was required as silicon.

Fig. 15 shows a similar series of fractures obtained on adding nickel to an iron containing initially 0.5 per cent. of silicon. Fig. 16 illustrates a typical series of the fractures of the split chilled bars, showing the effect of nickel additions between 3.5 and 15 per cent. to the original iron.

Fig. 2 presents in diagrammatic form, the natures of the fractures of the various thicknesses of steps in the step-bar castings of the series showing chill.

Table VI and Figs. 3, 4 and 5 show the actual measurements of the depth of chill on the series containing 0, 0.5, and 1.2 per cent. of silicon with increasing nickel. The analyses of these alloys are given in Tables I to V. The effect of nickel in reducing the depth of chill was very marked. It will be noted that the depth of chill (white)

Table V.—*Initial Silicon, 3.35 per Cent.*

Test No.	60	61	62	63	64	65	66	67	68	69
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Comb. carbon ..	1.16	1.17	1.16	1.19	1.15	1.03	1.16	1.10	0.88	0.84
Graph. carbon ..	2.22	2.18	2.21	2.18	2.20	2.15	2.00	1.95	1.92	1.90
Silicon	3.34	3.33	3.32	3.32	3.35	3.34	3.42	3.43	3.52	3.65
Nickel	Trace	0.48	1.02	1.69	2.52	3.61	5.16	7.47	9.94	13.72

was equal for specimens 10 and 05. The former contained about 0.5 per cent. of silicon and no nickel, and the latter about 2.4 per cent. of nickel and low silicon. Again test 40 corresponded to a test in the first series, midway between 06 and 07, indicating that the sample with 1.2 per cent. of silicon was equivalent to a sample with about 4.3 per cent. of nickel. Hence equivalent amounts of nickel and silicon are indicated as in the order of 4 to 1. With higher silicon and nickel, white iron was entirely absent on chilling, a very fine grey fracture being obtained on chilled sections.

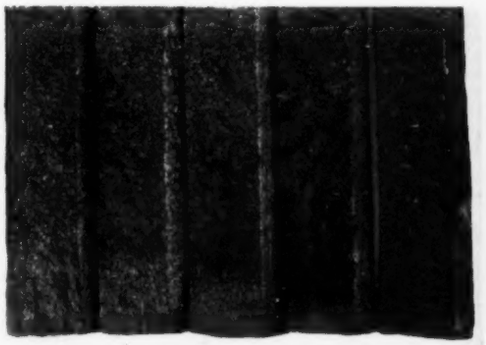

Fig. 16.—Typical Series of Chill-Bar Fractures.

Table VI.—*Depth of Chill.*

(*a*) *Initial Silicon, Nil.*

Test No.	00	04	05	06	07	08	09	010
	in.	in.	in.	in.	in.	in.	in.	in.
White	All	1	0.75	0.6	0.4	0.25	0.17	0
White and mottled	—	2	1.25	1.0	0.7	0.5	0.25	0

(*b*) *Initial Silicon, 0.5 per Cent.*

Test No.	10	11	12	13	14	15
	in.	in.	in.	in.	in.	in.
White..	0.75	0.70	0.65	0.55	0.4	0.35
White and mottled..	2.0	1.5	1.3	1.0	0.8	0.5

(*c*) *Initial Silicon, 1.2 per Cent.*

Test No.	40	41	42*	43	44	45	26	27
	in.	in.	in.	in.	in.	in.	in.	in.
White	0.5	0.45	0.47	0.32	0.3	0.25	0.2	0.1
White and mottled	0.6	0.55	0.57	0.4	0.35	0.3	0.25	0.1

* Pouring temperature high.

Microstructure of the Alloys in the Cast Condition.—For micro-examination, a specimen was cut from each casting, ½ in. from the end of the 1-in. section, and the cut face polished. Unmachinable specimens were cut with a slitting grinding wheel, care being taken to keep the specimen as cool as possible. Micrographs were taken at corresponding points on each specimen with the specimens unetched and etched.

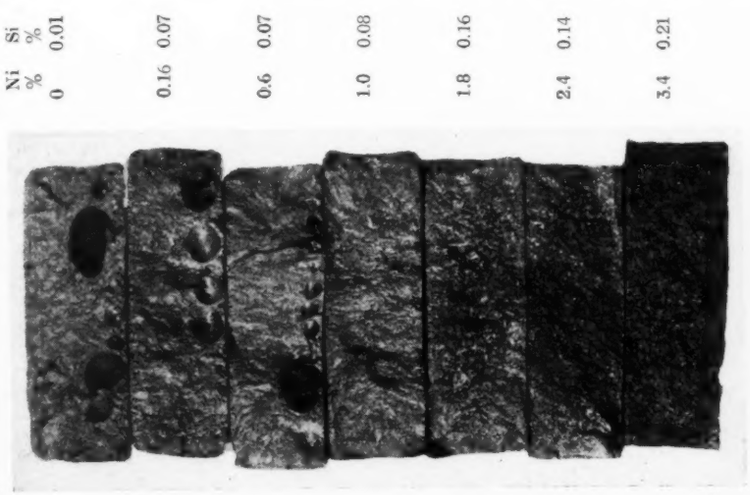

Fig. 14.—Fractures of ½-in. Section. Initial Silicon, Nil.

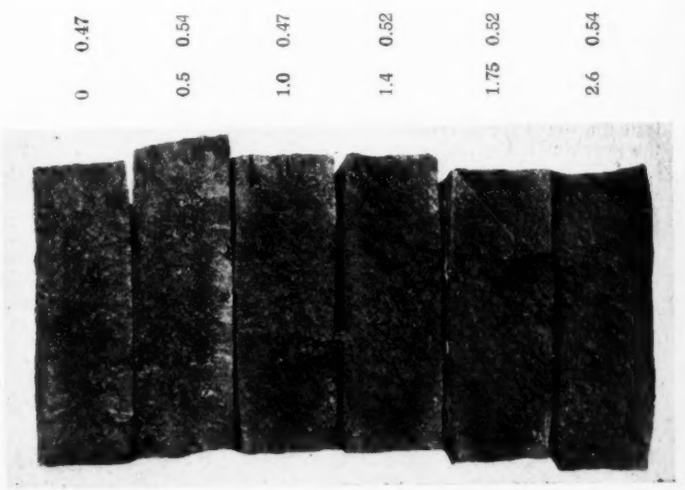

Fig. 15.—Fractures of ½-in. Section. Initial Silicon, 0.5 per cent.

Influence of Nickel on the Graphite.—It has already been pointed out, under the heading of "chill" that nickel will graphitise a white iron. Consequently the first effect of nickel on low-silicon iron was to increase the quantity of graphitic carbon. On adding nickel to the original washed iron, this carbon appeared first only in the small round pearlitic areas towards the centre of the specimen. On adding more nickel, these areas carrying graphite increased in size until of the alloys examined. In fields 1, 2, 3, and 4 the primary austenite in the iron had broken down to pearlite or sorbitic pearlite. In field 1, bounded by the line *AA*, the structure showed the presence of austenite-cementite eutectic, corresponding to the existence of white or mottled irons. A typical example of this structure is shown in Fig. 17. The amount of the austenite-cementite eutectic decreased as *AA* was approached.

the structures of the following alloys correspond to each other:—

Silicon, per cent.	0.47	1.48	3.65
Nickel, per cent.	7.31	9.44	13.72

Again:

Silicon, per cent.	0.56	1.7
Nickel, per cent.	10.7	13.8

And also:

Silicon, per cent.	1.39	3.52
Nickel, per cent.	7.08	9.94

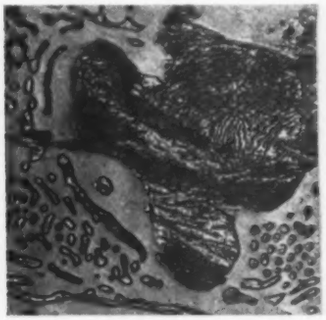

Fig. 17.—Nickel 0.16 per cent., Silicon 0.07 per cent. × 500. [1.]

Fig. 18.—Nickel 4.91 per cent., Silicon 0.29 per cent. × 500. [2.]

Fig. 19.—Nickel 0.98 per cent., Silicon 2.22 per cent. × 500. [3.]

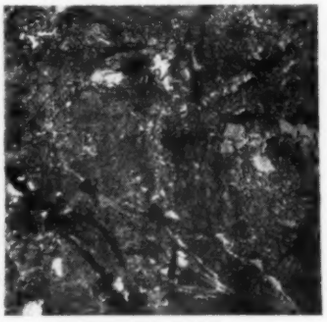

Fig. 20.—Nickel 3.38 per cent., Silicon 1.33 per cent. × 500. [4.]

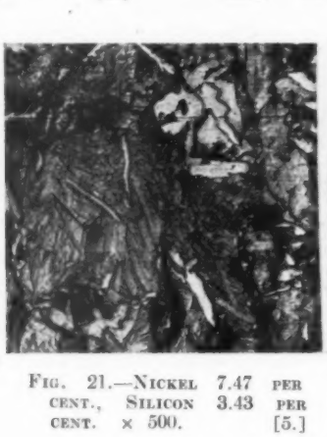

Fig. 21.—Nickel 7.47 per cent., Silicon 3.43 per cent. × 500. [5.]

Fig. 22.—Nickel 7.08 per cent., Silicon 1.39 per cent. × 500. [6.]

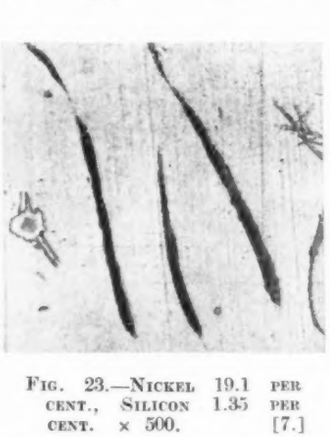

Fig. 23.—Nickel 19.1 per cent., Silicon 1.35 per cent. × 500. [7.]

[The Numbers in Square Brackets refer to Fig. 7.]

they covered the whole specimen. This graphite was in the form of fine flakes, as shown in Fig. 6.

Eutectic graphite (fine graphite from the austenite-graphite eutectic) was seen in the specimens with over 5 per cent. nickel. The quantity of graphite, however, was nearly constant above 2 per cent. of nickel (see Table I) throughout the remainder of Series 0. Above 20 per cent. of nickel the graphite flakes became larger, thinner, and straighter, and approximated to the appearance of graphite in cast nickel. If the iron were partially graphitised in the first place by a small silicon content, then, in general, the graphite present was fine. The addition of nickel to such an iron continued the graphitisation of the iron, but the graphite flakes remained in a fine form. If, however, the initial silicon content of the iron was high enough to give coarse graphite, then the addition of nickel appeared to render the graphite flakes finer. With very high silicon (3.3 per cent.) this effect was less marked. In the case of these irons the maximum refining of the graphite appeared at about 2.5 to 3 per cent. As will be seen from the tables of analyses, no reduction in the quantity of graphitic carbon was obtained; the refining consisted entirely in a reduction of the size of the flakes. With higher additions of nickel (above 5 per cent.) fine, thin, straight flakes of graphite were obtained for all silicon contents.

General Microstructure.—Fig. 7 shows diagrammatically the microstructure of the alloys examined, and the micrographs, Figs. 17 to 23, are typical of the different structures indicated in the diagram. The dots show the compositions

In fields 2, 3, and 4 the alloys showed pearlitic structures. In field 2 the pearlite was associated with needles of pro-eutectoid cementite and graphite (Fig. 18) the limit of existence of this type of structure being marked at *BB* in the diagram.

In fields 2 and 4 the pearlite was very fine or sorbitic (Figs. 18 and 20). In field 3 the pearlite showed well-developed laminations (Fig. 19). In all the alloys, as the line *CC* was approached on the addition of nickel, the pearlite became finer and more sorbitic. Beyond *CC* the structure became martensitic. Close to *CC* alloys were found showing a completely martensitic ground-mass (Fig. 21) but beyond this narrow region the structure always showed mixed austenite and martensite (Fig. 22) with martensite decreasing as the limiting line *DD* was approached. Beyond *DD* the alloys were austenitic (Fig. 23).

A white phase of undetermined constitution, but possibly consisting of carbide, seen in Fig. 21, was associated with some of the high-silicon, high-nickel alloys, and crystals probably of carbides, as seen in Fig. 23, occurred throughout the series.

It is contrary to expectation that the principal field boundaries should curve over towards the right-hand side of the diagram. This indicates that the production of a given structure in a high-silicon alloy requires the addition of more nickel than is required to produce that same structure in a low-silicon alloy; in other words, the silicon inhibits the changes produced by the addition of nickel. This is confirmed by a further study of the microstructures, for it is found that

It is of interest to note also that with the highest silicon contents used, and in a 1-in. section, no ferrite (except possible traces in one or two cases only amidst the pearlite) is seen. It seems possible that the production of ferrite in cast iron is profoundly influenced by the presence of elements other than silicon; comparison with ordinary cast irons would have led one to anticipate that ferrite certainly should have been formed in the alloys investigated under the conditions of moderately slow cooling in the 1-in. section, with an iron having high total carbon and high silicon.

Influence of Nickel on Pearlite.—It was found that the addition of small amounts of nickel to an iron showing laminated pearlite caused the structure of the pearlite to become finer, and ultimately sorbitic. This effect again was masked by high silicon.

Effect on the Carbide.—The statement that nickel renders the carbide constituent more acicular cannot be confirmed, for the pro-eutectoid cementite, occurring in a low-silicon iron is already in an acicular form and does not appear to be modified by the presence of nickel: as shown in Fig. 7, the quantity of this carbide is decreased by the addition of either silicon or nickel.

(To be continued.)

The wages regulated by the sliding scale under the Midland Iron and Steel Wages Board were reduced 2½ per cent. from Monday, October 3, the lower rate to remain in force until Saturday, December 3.

The Cause of Variations in Pig-Iron Qualities.*

By R. S. McCaffery,† Madison, Wis.

That certain irons possess definite properties quite different from other irons of exactly the same chemical composition has been noted for a long time, and for years pig-irons from some furnaces have had such a reputation for possessing desirable qualities that they have commanded a higher than average price on the market. Buyers have been willing to pay the advanced price because they believed they were getting some thing or property in these irons which they did not obtain in other irons.

Theories Advanced to Account for Variations.

Among technical men at the present time the belief that one iron has properties different from another iron of the same chemical composition is very generally accepted as a fact, and explanations have been offered to account for the differences. Generally two major theories have been advanced, which have been called the "oxygen" theory and the "rare elements" theory. The names are nearly self-explanatory. The arguments *pro* and *con* concerning these theories have been warmly supported and a considerable literature has come into being as a result.

Recently, Fletcher‡, in his exchange paper developed some ideas which seem to have great merit, and the work of Piwowarski§ and his associates in their study of cast irons of great strength have added additional information on this general subject. This present Paper is presented merely as the statement of a theory as to the cause of variation in the qualities of iron, which it is believed accords with the observed facts. It is in no wise a report of experimental research, but it is the result of careful study of the problem and believed to be in accord with scientific principles. To the writer at least, it does not require so expansive an imagination as do the older theories.

Pig-iron or cast iron will always be found on chemical analysis to contain iron and manganese and carbon, silicon, sulphur and phosphorus. With the exception of part of the iron and carbon which may exist in the pig-iron in the elemental form as ferrite and graphite, all the commoner metallic constituents of the pig-iron form compounds with the non-metallic constituents which may be present and binary compounds like carbide of iron, carbide of manganese, silicide of iron, silicide of manganese, sulphide of iron, sulphide of manganese, phosphide of iron and phosphide of manganese, as well as possible compounds more complex than binaries, may be present in the iron.

Conditions in a Blast Furnace Not Uniform.

In a blast furnace producing pig-iron the conditions are not uniform at any one time in the furnace nor are they uniform from day to day, and when two blast furnaces are compared the lack of uniformity becomes more apparent. In any horizontal section of a blast furnace there is considerable variation in temperature, and there is not a proportional change of temperature between the corresponding points in any two different horizontal sections. The result of this is that along any vertical line inside of a blast furnace there is at some fixed time a definite temperature gradient which is different from the temperature gradient along any other vertical line at the same time. If a particle of ore that was charged into the top of the furnace descended through the furnace along one of these lines it would pass along a temperature gradient quite different from what a second particle would be subjected to along another path down the furnace. When the temperature gradients may be so different in various paths through one furnace, a still greater variety of temperature gradients are to be expected in two furnaces.

All chemical reactions have a definite free energy at a given temperature and with some reactions the free energy increases as the temperature rises, while with other reactions the free energy decreases with rising temperature. This means that all chemical reactions have a velocity that varies with the temperature and that chemical affinities vary with temperature.

Reactions May Vary at Different Temperatures.

It means, too, that when a number of chemical reactions are taking place simultaneously at a given temperature one reaction will predominate over the others, while at a different temperature another reaction will predominate, although a number of reactions may all be taking place at the same time to a greater or lesser degree. Metallurgists are familiar with the fact that in normal Bessemer blows the silicon is first oxidised and afterwards the carbon is blown out; whereas in a blow that starts at an initially higher temperature the silicon is eliminated after the carbon. Similarly in a basic open hearth heat, normally the phosphorus is taken out first and the heat finished on carbon, but by beginning a heat at a high initial temperature the carbon may be removed first and the phosphorus may remain to the last. In malleable air furnace heats, too, the order of elimination of impurities from the bath may be varied by control of the bath temperatures.

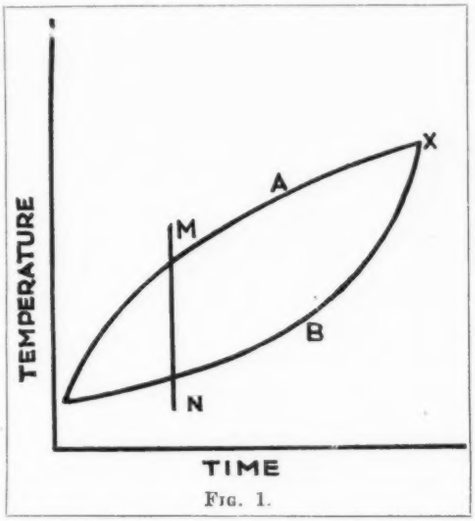

FIG. 1.

The importance of this point and its full significance is emphasised by reference to Fig. 1. Two baths of molten metal, both of the same initial temperature and compound composition, and in each of which reactions are taking place, are heated. In the same total time both reach the same final temperature, one passing along the temperature gradient A while the other passes along B. Let us consider what is happening at the time represented by the line M, N. In the bath A a number of reactions are taking place at the same time, and each is producing its own end product. All of them are progressing at different rates, and one reaction is predominating over the others. In the bath B, at the point N, the same reactions are occurring, *but at different rates, because the temperature is lower* than at M in bath A and a different reaction may be predominating. In any event, since the rates of reaction are different at M and N, the bath compositions are different. Similarly, at other equal time points along A and B, the reactions proceed at different rates till the point X is reached, which is at the same time in each bath, but by proceeding along a different temperature gradient. The result is the two baths now at temperature X are not of the same compound composition, although both started with the same composition and in the same time reached the same final temperature. It is assumed that the heating of the metal baths was carried on at an economic or commercial rate, and that equilibrium was never attained, or, in ordinary words, common practice in heating was followed.

The fact that two molten metal baths may reach the same temperature in the same time but be of different compound composition is a point of considerable importance that is overlooked in plants, and it may account for variations in the properties of heats of the same chemical composition that are explained usually in various other ways.

Reactions in Blast Furnace Vary with Change of Temperature.

In the blast furnace there is a series of reactions taking place. The velocities of these reactions change with the furnace temperature. In the passage of the particles down the furnace the temperature rises and the order of the reactions keeps changing. All parts of the charge are not carried down the shaft along the same temperature gradient, so that the reactions are not taking place uniformly at one place in the furnace and uniformity of conditions is not maintained. Then, too, there are irregularities in the operation of any blast furnace due to the changes that are taking place in various operating factors, and the same *average* temperature gradient does not persist from hour to hour, let alone from day to day. The reactions that take place in the furnace produce the various carbides, silicides, sulphides and phosphides of iron and manganese. It can be seen, then, that along different temperature gradients, one kind of iron of a definite compound composition may be produced by passage along one temperature path, while iron of different compound composition results from taking another path. It may be, too, that while the compound composition is different in the two cases, the chemical composition may be the same; for example, the carbon may be present all as carbide, and in one iron the iron carbide might be high and the manganese carbide might be low, while in the second the iron carbide might be low and the manganese carbide high, although the carbon might remain exactly the same in the two irons.

Properties of Iron Partly Due to Compound Composition.

The properties of the iron are not entirely due directly to its chemical composition, but its compound composition may profoundly influence its properties.

If two pig-irons are of the composition indicated in Table I they may have the same chemical composition as shown in Table 2; but, because their compound composition is different (although the chemical analysis is the same), the properties of the two will be different.

TABLE I.

	No. 1 Iron. Per cent.	No. 2 Iron. Per cent.
Iron carbide	*a*	*m*
Iron silicide	*b*	*n*
Iron sulphide	*c*	*p*
Iron phosphide	*d*	*q*
Manganese carbide	*e*	*r*
Manganese silicide	*f*	*s*
Manganese sulphide	*g*	*t*
Manganese phosphide	*h*	*u*

TABLE II.

	No. 1 Iron. Per cent.	No. 2 Iron. Per cent.
Iron	*J*	*J*
Manganese	*K*	*K*
Carbon	*L*	*L*
Silicon	*M*	*M*
Sulphur	*N*	*N*
Phosphorus	*P*	*P*

It may be objected that the amounts of some of the compounds which might be present will be small, and therefore their influence on the properties of the iron will be slight. It is known,

* Paper presented to the Chicago meeting of the American Foundrymen's Association.

† Professor, College of Engineering and Mechanics, University of Wisconsin.

‡ Fletcher, J. E., "Some Fundamental Relationships in Cast Iron, Wrought and Steel Manufacture," Trans. Amer. Foundrymen's Assoc., vol. 33, pp. 6-34.

§ Piwowarski, E., "Progress in Production of High-Test Cast Iron," Trans. Amer. Foundrymen's Assoc., vol. 34, pp. 914-981.

however, that relatively small amounts of compounds will affect the properties of steel to an important extent. The presence of sulphur as a compound of iron as FeS, or of manganese as MnS, is a case in point when the higher melting point of the manganese sulphide causes it to separate in grain interiors instead of on grain boundaries, as does the lower melting point iron sulphide, and it thus changes materially the brittleness of the steel. The amount of these compounds, too, will be larger than the content of "rare elements" or of "oxygen," or other gases which has satisfied the supporters of some of the other theories.

The theory outlined in this paper has been reduced to its simplest form; for one thing, the effect of solubility of constituents has not been considered. In its most elementary outline, it indicates how the relative amounts of compounds which may be present in pig-iron might change, due to variation in blast furnace operating conditions. When we consider that some of these compounds may vary by considerable percentages, the variation in the properties of pig-irons of similar analysis but produced under different conditions does not seem so extraordinary. It has been repeatedly noted that certain irons retain their characteristics to a greater or less extent after remelting a number of times. If this be so, it gives additional support to the proposed new theory. Certain temperature conditions in the blast furnace cause some reaction to predominate at definite temperatures, and produce definite end products or compounds in the iron. If then on re-melting, this temperature range in which the compounds were formed in the blast furnace is not attained, or if it should be reached but only for a short time, then the compounds formed at the higher temperatures persist, and the iron only liquefies. On cooling and solidifying again, it has the same or approximately the same compound composition, and retains, therefore, to a greater or less extent, its original properties. The theory advanced in this Paper does not attempt to ascribe all the properties of the iron to the compounds which may be present. The alloy structure is most important. There are other things, however, besides what might be called the gross structure which may profoundly influence properties. It is suggested that as in the ordinary processes of manufacture, there are variable factors which greatly change the compound composition, that possibly this may account for observed differences in pig-iron qualities.

The writer is using the theory tentatively to outline experimental work, and is not so committed to it that the results of this experimental work may not cause him to throw it overboard or to modify it considerably, but as a working tool it seems to have some use.

Book Review.

Data for Engineering Inquiries. By T. C. Connan.—Published by Sir Isaac Pitman and Sons, Limited, Parker Street, Kingsway, London, W.C.2. Price 12s. 6d.

This book consists of a well-thought-out collection of inquiry forms giving the particulars desirable to be included when asking for prices. We will grant immediately that the book is an excellent compilation and is well arranged, but we insist that it should not be used by the ordinary buyer for anything out of the usual run of things, rather should it serve the engineer really interested as a reminder in order that time and energy will be saved to both supplier and user. For example, in preparing an inquiry for an electric steel melting furnace the buyer is definitely not in a position to write a suitable letter without referring to the works management. If he does attempt it he will probably make some glaring errors and create a false impression with the suppliers. The aspect of the book which we are endeavouring to stress can best be illuminated by pointing out the gastronomic danger of mistaking a cookery book for a cook. We think that our readers will best understand the true purport of the book by alluding to it as the Purchasing Agent's "Mrs. Beeton."

The Influence of Alkaline Salts upon Molten Iron.

P. Bardenheuer and H. Ostermann* made experiments in order to study the reactions taking place in the desulphurisation of molten iron by alkaline salts. The first experiments were carried on in carbon crucibles with carbonate of sodium and melts of different composition. The results are given in Table I. It is seen that when the molten iron only contains sulphur besides carbon a desulphurisation does not take place; when silicon is present in the place of sulphur there occurs a diminution of the silicon content and a slag is formed upon the melt. When both silicon and sulphur are present the contents of both these elements are lowered and a slag is formed. These facts show that the desulphurisation is connected with the formation of a slag which occurs when silicon is present in the iron. When silicon or ferro-silicon is added together with carbonate of sodium a desulphurisation of the iron occurs without altering its silicon content; this combined flux, moreover, can desulphurise an iron which contains no silicon.

Table I.

Melt No.		Si.	Mn.	S.
		Per cent.	Per cent.	Per cent.
1	Before adding the carbonate ..	—	—	0.18
	After adding the carbonate ..	—	—	0.20
2	Before adding the carbonate ..	—	—	0.18
	After adding the carbonate ..	—	—	0.17
	Before adding the carbonate ..	1.92	—	0.17
	After adding the carbonate ..	1.82	—	0.13
	Decrease in per cent.	5.20	—	23.50
3	Before adding ..	1.89	—	—
	After adding ..	1.82	—	—
	Decrease in per cent.	3.70	—	—
	Before adding ..	1.82	—	0.18
	After adding ..	1.62	—	0.12
	Decrease	11.00	—	33.30
4	Before adding ..	2.33	—	—
	After adding ..	2.14	—	—
	Decrease	8.15	—	—
	Before adding ..	2.14	—	0.18
	After adding ..	1.99	—	0.12
	Decrease	7.00	—	33.30
5	Before adding ..	—	0.31	0.23
	After adding ..	—	0.23	0.16
	Decrease	—	25.80	30.50
6	Before adding ..	—	0.18	0.21
	After adding ..	—	0.14	0.14
	Decrease	—	22.30	33.30
7	Before adding ..	1.33	0.60	0.40
	After adding ..	1.08	0.30	0.15
	Decrease	18.80	50.00	66.00

The slag formed is vitreous and is caused by the silicon reducing the Na_2O and thereby being oxidised to silica which with the aid of the unreduced Na_2O forms a silicate according to the equation:—

$$Na_2O + SiO_2 = Na_2O.\ SiO_2.$$

The silicate dissolves the Na_2S thereby stopping it from re-entering the bath. When a mixture of carbonate of sodium and carbide of calcium is used the silicon loss of the melt is diminished with the increasing amount of carbide, but can not wholly be eliminated. Moreover, the degree of desulphurisation increases up to a certain ratio of the mixture. Therefrom it can be concluded that the silicon can be replaced by the carbon as a reducing agent but not as a slagging one. The addition of metallic sodium to the melt has no effect as the sodium vaporises. The same is the case with a mixture of metallic sodium and an alkaline silicate. The silicate cannot desulphurise the iron because it cannot decompose on the surface of the bath. A mixture of carbonate of sodium and silica, however, brings about a desulphurisation if more Na_2O be present than can be satisfied by the silica. The efficiency of the carbonate of sodium is diminished with the increasing temperature as the amount of the vaporised sodium increases. Therefore it is impossible to desulphurise steel baths with the aid of alkaline salts. The degree of desulphurisation increases with the increasing amount of the added flux, though not proportionally. The end of the reaction depends upon the amount of the unsatisfied Na_2O. The silicon which reduces the Na_2O forms silica which, on the other hand, combines with Na_2O to form a silicate. Thus the silicon is the main factor which regulates the amount of the free Na_2O, that is the end of the reaction. Therefore in adding the same amount of Na_2O to the melts with different silicon contents the silicon losses will not differ greatly from each other. This can be seen from the experiments recorded in Table II. On the other hand the amount of sulphur removed from the melts increases with the increasing sulphur contents according to the empirical fact that the sulphur is the easier removed, the higher the sulphur content is. The figures of Table II also show that the efficiency of the carbonate of sodium is the same as that of Walter's desulphurising agent. From Table I it is to be seen that when sulphur and manganese are present in the melt there also occurs a desulphurisation, connected with the formation of a slag which is not vitréous. The loss of manganese can be explained by the segregation of MnS which may also be responsible for the formation of the slag. In further experiments the authors examined the formation and the composition of the various slags.

Table II.

Melt No.		Si.	S.	Temp.	Flux Added.
		Per cent.	Per cent.	Deg. C.	
8	Before adding	2.78	0.022	1,350	Na CO
	After adding ..	2.65	0.013	—	
	Decrease ..	0.13	0.009	—	
9	Before adding	2.37	0.086	1,400	,,
	After adding ..	2.19	0.047	—	
	Decrease ..	0.18	0.039	—	
10	Before adding	2.02	0.061	1,350	,,
	After adding ..	1.88	0.045	—	
	Decrease ..	0.14	0.016	—	
11	Before adding	0.43	0.17	1,400	,,
	After adding ..	0.28	0.087	—	
	Decrease ..	0.15	0.083	—	
12	Before adding	2.37	0.086	1,380	Walter's
	After adding ..	2.21	0.044	—	Agent.
	Decrease ..	0.16	0.042	—	
13	Before adding	2.03	0.079	1,400	,,
	After adding ..	2.03	0.044	—	
	Decrease ..	0.19	0.023	—	
14	Before adding	0.43	0.17	1,360	,,
	After adding ..	0.28	0.091	—	
	Decrease ..	0.15	0.079	—	

Weight of the melts: 500 grms. Amount of flux: 3 grms.

Publication Received.

The Other 65 per cent.—This publication has been sent to us from Mr. G. J. Jones, of No. 1, The Ferns, Addington Grove, Sydenham, S.E.26, its author. We have never encountered anything of the kind before. It sets out a series of eleven business-getting letters, the second of which relates to castings. This letter is quite good, only it is obvious that the author has had insufficient instruction as to the requirements of castings. "Castings which you cannot break" would not appeal to many buyers, unless they were after dredger buckets or crusher jaws. However, that is by the way, the object of the series being to disclose a novel service, that of the "professional correspondent." We gather the idea that inasmuch as advertising messages require copy writers, so do the sales letters require a mentality specially suited for goading the recipient to an action other than that of the small effort required to assign it to the waste-paper basket. We candidly confess that there is something novel and human about the appeal of the letters contained in this booklet, and we believe foundry owners would find them interesting.

* Die Giesserei, 1927, No. 19, pp. 305-7.

The Works of David Colville & Sons, Limited, Clydebridge Steel Works.

These Works are situated on the banks of the River Clyde at Cambuslang, about three miles from Glasgow, and are served by the London, Midland and Scottish Railway Company. The old portion of the Works, not now in use, was opened by the Clydebridge Steel Company, Limited, in 1888. The Works were acquired by Messrs. David Colville & Sons, Limited, in the early years of the war, and used for the manufacture of steel billets capable of conversion into high-explosive shells, the old cogging mill being converted into a billet mill. To bring the old plate mills into use for the manufacture of standard ships, a new melting shop with a slab-cogging mill was erected on land adjoining the works, and since the war the company have added a three-high plate mill with the necessary auxiliaries. The plant at present in operation comprises melting shop, slab-cogging mill, re-heating furnaces for ingots and slabs, three-high electrically-driven plate mill, cooling floor, shearing and loading plant and other auxiliaries.

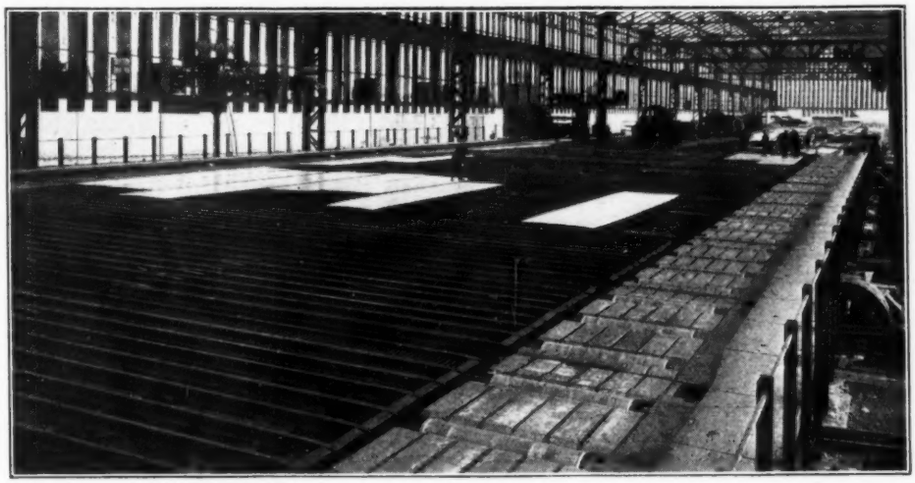

Fig. 1.—Clydebridge Works of David Colville & Sons, Limited. Plate Mill Cooling Floor.

Melting Shop.—This consists of three main bays with a lean-to. The first span is that over the marshalling and stock bay, which is 71 ft. wide by 470 ft. long. The next two bays are those over the furnaces and casting bay, 70 ft. and 66 ft. span respectively by 560 ft. long each. The open-hearth furnaces, of which there are five, are each 32 ft. long between the blocks and 13 ft. wide inside the walls. They are served by two revolving open-hearth charging machines, which can lift the charging boxes from trestles in the stock bay and empty their contents into the furnaces. The stock bay is served by two overhead cranes provided with lifting magnets, which can take scrap or pig-iron direct from wagons or stock piles and deliver it into the charging boxes. The casting side of the furnaces is provided with two special 100-ton ladle cranes for handling the steel ladles and carrying them over the ingot moulds standing in a row on the opposite side of the casting bay from the furnaces. There are also two cranes to strip the ingots and convey them to the soakers.

The gas for firing the open-hearth furnaces and the ingot re-heating furnaces is generated in a battery of 15 wet-bottom gas producers situated under the lean-to above referred to. They gasify at the rate of about 14 cwts. per hour and deliver a gas having a net calorific value of about 152 B.T.U. per cub. ft. Before leaving the melting shop reference may be made to the waste-heat boilers, of which there is one to each open-hearth furnace. They are of the Babcock & Wilcox water-tube type, each having a heating surface of 2,913 sq. ft. In series with each boiler is a Green's economiser, having a heating surface of 1,900 sq. ft. The effect of boiler and economiser is to cool the waste gases down to about 171 deg. C.; and to maintain the necessary draft at the furnaces electrically-driven induced-draft fans are installed.

Cogging Mill.—The building which accommodates the ingot re-heating furnaces and the cogging mill is at right-angles to the melting shop, and has a span of 70 ft. It was originally 390 ft. long, but has since been extended a further 150 ft. to accommodate the three-high plate mill and motor house. The ingot re-heating furnaces, of which there are two, are of the vertical gas-fired regenerative type, the covers being handled by a cover-lifting machine which runs over the furnaces and which is electrically-operated. The ingots are handled by a self-dogging crane, which can take the ingots direct from the melting shop and place them in the re-heating furnaces, and when at a rolling temperature can transfer them to the cogging mill. The slab-cogging mill was made in the Company's own works. It has rolls 33 in. diameter by 7 ft. 6 in. long, and is driven by a pair of horizontal non-condensing reversing engines, having steam cylinders 48 in. in diameter by 54-in. stroke and is geared to the mill in the ratio of 2.67 revolutions of the engine to one of the rolls. The mill is provided with the usual live-roller racks and screw-gears electrically-driven and with hydraulic tilters and side adjusters. After cogging, the slabs are cut to size in a steam-hydraulic slab-shearing machine capable of cutting slabs 10 in. thick by 40 in. wide. It is provided with live rollers, floating table, length gauge and scrap-handling device. The mill and shears are served by a 40-ton electric crane.

Main Boiler Plant.—Steam for the cogging mill and for the steam intensifier is generated in four Babcock & Wilcox water-tube boilers. Each has a heating surface of 6,182 sq. ft., and is provided with chain-grate stoker and integral superheater. The working pressure is 150 lbs. per sq. in. and the superheat is from 100 deg. to 120 deg. Fah. Attached to each boiler is a Green's economiser, having a heating surface of 2,000 sq. ft. The fuel is mechanically handled by gravity bucket conveyors. The hydraulic power for tilters, etc., is supplied at a pressure of 750 lbs. per sq. in. by a set of three-throw horizontal ram pumps electrically-operated through gearing and under the control of an accumulator.

New Plate-Mill Plant.—The re-heating furnaces are housed in a building of two bays parallel to the cogging mill building. The furnace bay is 65 ft. wide by 300 ft. long, whilst the producers are in a building 35 ft. wide and of the same length as the furnace bay. The crane girders, however, extend 45 ft. beyond the building to command the fuel pit into which the fuel is tipped from the railway wagons.

Re-heating Furnaces.—These, of which there are four, are of the Siemens new form with integral gas producers. Each furnace was designed to heat a minimum of 1,000 tons of slabs per week on a fuel consumption not exceeding 2 cwts. per ton of slabs heated. The fuel for the producers and the ashes from them are handled by an overhead crane provided with a grab bucket. The furnaces are served by two overhead electrically-operated slab-charging machines of the side-grip type. These take the slabs from a rack at floor level leading from the cogging mill and charge them into the furnaces, and when heated withdraw them and

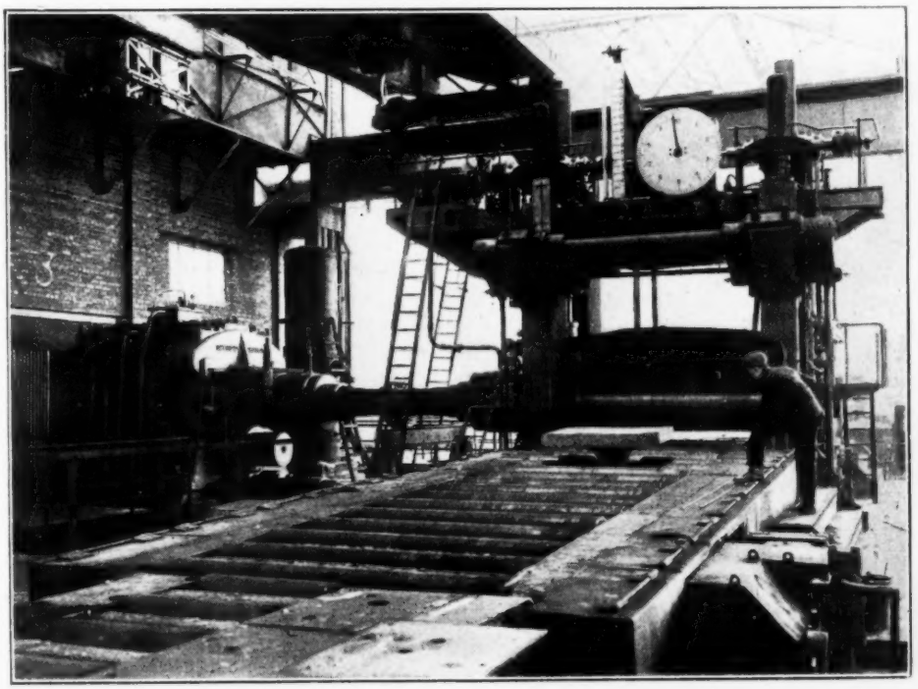

Fig. 2.—Clydebridge Works of David Colville & Sons, Limited. Electrically-driven Three-high Plate-rolling Mill (Entering Side).

place them on the approach rack of the plate mill.

Three-High Plate Mill.—This mill is of the Lauth type, and embodies the best features of American, British and Continental practice. It has main housings of steel. The top and bottom rolls are 36 in. diameter, whilst the middle roll, which is not driven, is 24 in. diameter, the length of each being 9 ft. Double-helical machine-cut pinions 36 in. in diameter by 56 in. wide are used, which are connected to the top and bottom rolls through universal couplings. The drive from the motor is taken through a central pinion 28 in. diameter, to which it is connected by a hydraulically-operated clutch. The pinions are supplied with forced lubrication. On each side of the mill there is a lifting table, hinged at the end remote from the mill, operated by electric motors. On the entering side of the table there is a hydraulically-operated turntable to turn the slabs through 90 degrees. There are also side-adjusters on each side of the mill to centre the slab or plate. The mill is operated from a control platform, on which are located all switches and hydraulic valves for the several operations; also those for operating the re-heating furnace doors. On the outgoing side of the mill there is a rack leading to a plate-flattening machine or mangle. This machine is of the nine-roller type, having steel rolls 16½ in. diameter by 9 ft. 6 in. long. It is electrically-operated. Leaving the mangle, the flattened plates are conveyed along a live-roller rack, which extends the full length of the cooling floor and is divided into two sections. When sufficiently cooled, the plates are marked off for shearing and conveyed by magnetic skids to a similar live-roller rack, which conveys them to the shearing plant.

Shearing Plant.—The shearing plant, cooling floor and loading bays are housed in a spacious building at right-angles to the cogging-mill building, and therefore parallel to the melting shop. It is 100 ft. span by 900 ft. long, the roof being entirely of glass. The live-roller rack, previously referred to, leads into the first or cross-cutting shear, which removes the end scrap, and, if the plate has been rolled in multiple lengths, cuts it into pieces. Rectangular or only slightly taper plates are then dealt with in two side-cutting shears, one of which shears the right-hand and the other the left-hand side of the plate. In front of each machine is an Ennis patent manipulating table, which consists of a travelling carriage, having mounted on it live rollers and cross-traversing electro-magnets. When the plate has been received on these tables the adjusting magnets are energised, and, being independently movable, adjust the plate to the shearing line. The table then travels forward, carrying the plate between the shear-blades, which are then set in motion and a cut made. The table then travels forward again, and so on till the whole side of the plate is sheared. When one side is finished the plate is passed on to the other machine, which similarly deals with the other side. All the operations, including the working of the shearing machine, are performed by the man on the Ennis table. A feature of these side-cutting shears is that each has a cross-cut blade which cuts the scrap into lengths which can go into the charging boxes, and so can be returned to the melting shop with the minimum of handling. For special work diameters, sketch plates and splitters there is a shearing machine provided, having a width of 9 ft. between the housings and a gap 3 ft. 6 in. deep. In front of this machine is a group of casters to carry the weight of the plates being handled. All the above shearing machines are hydraulically-operated at a pressure of 1,500 lbs. per sq. in., and each has three powers, so that water and power may be saved. In addition to the above, there is an old electrically-driven shear to cut up the long scrap from the sketch shears and for test-pieces, etc. The hydraulic power for the shearing machines is supplied by three sets of electrically-operated horizontal three-throw ram pumps, one spare. Two accumulators are provided and arranged to control the pumps, which come into operation one after the other, so that never more than the necessary number are in operation at any one time. The plates after shearing are conveyed on a live-roller rack to the loading bay. The last length of the rack is provided with a weighing machine, having arms which come up between the rollers and lift the plate clear of them when being weighed. The plates are finally loaded by overhead cranes with electro-magnets mounted on Inglis patent telescopic beams.

Electrical Equipment.—The motor house is situated in the same bay as the three-high mill, from which it is separated by a partition to prevent mill scale, etc., from getting to the electrical plant. The current is taken from the Clyde Valley Electrical Power Company, Limited. From the sub-station the current, which is three-phase, is led to the E.H.T. switchboard, situated on a gallery at the outer end of the motor house. This board has three remote-control switches, one to receive the current from the sub-station, one to distribute it to the static transformers for the mill drive, and one to distribute it to the transformers for the rotary converter. The static transformers are situated in cubicles under the switchboard gallery. In connection with the mill drive there are three, one on each phase, which step the current down to a pressure of 3,300 volts. In connection with the rotary converter, there are also three which step the pressure down to 173 volts. The mill is driven by a reversible motor supplied with direct current from a flywheel equaliser set consisting of a 2,500-h.p. three-phase motor coupled direct to two variable-voltage direct-current generators. These generators are separately excited, and their armatures are connected in series. Between them is placed a 50-ton flywheel, 12 ft. diameter. The synchronous speed of the set is 500 r.p.m., and at this speed the flywheel has a stored energy of 160,000 h.p.-seconds. To permit of this energy being made available to assist in taking the peak loads, it is, of course, necessary to cause the set to drop in speed. This is effected by means of an automatic slip regulator which, when the current taken by the equaliser motor exceeds a pre-determined amount, puts resistance in the rotor circuit and so permits the set to slow down. The main mill motor consists of two shunt-wound direct-current separately-excited machines with their armatures rigidly coupled and connected in series with the V.V. generators previously referred to. It is designed to give 13,000 b.h.p. Its normal speed is 65 r.p.m. in either direction, up to which speed it gives constant torque. By weakening the field it is possible to increase the speed to 110 r.p.m. in either direction. At speeds between 65 and 110 revs. it gives constant horse-power. The exciter set is driven by a three-phase motor running at constant speed and driving three D.C. generators, one to excite the main mill motor, one to excite the V.V. generators, and one for speed regulation. The direct current supplies for the various motors about the plant is supplied by a rotary converter, which also acts as a power factor corrector. This machine receives A.C. current at 173 volts and delivers D.C. current at 220 volts, at which pressure all the motors for cranes, charging machines, live-roller racks and other auxiliary plant operate. It also supplies the current for lighting the works. The D.C. current is led to a switchboard on the gallery over the transformers, from whence it is distributed to the various departments. There is also a coupler panel which connects the new plant with the power station in the old works. There are the usual repair shops, both mechanical and electrical, mechanical test house, and chemical laboratories.

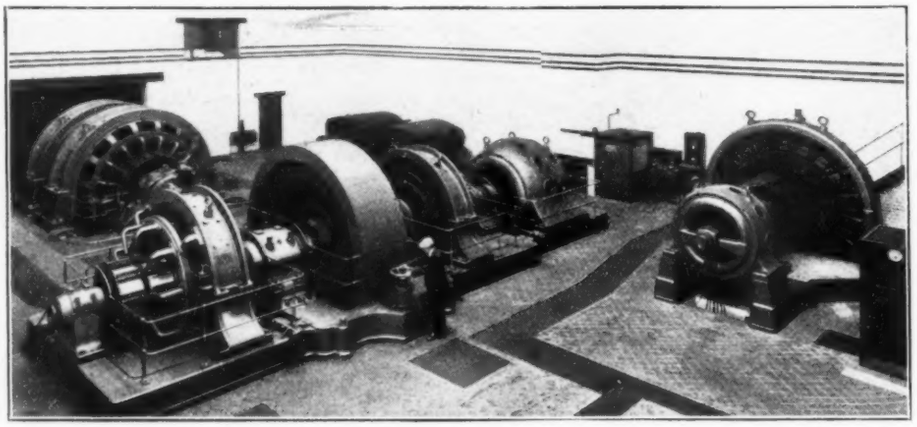

Fig. 4.—Clydebridge Works of David Colville & Sons, Limited. Electric Power House, showing 13,000-h.p. Motor driving Three-high Plate Mill; also Flywheel Converter Set and Rotary Converter.

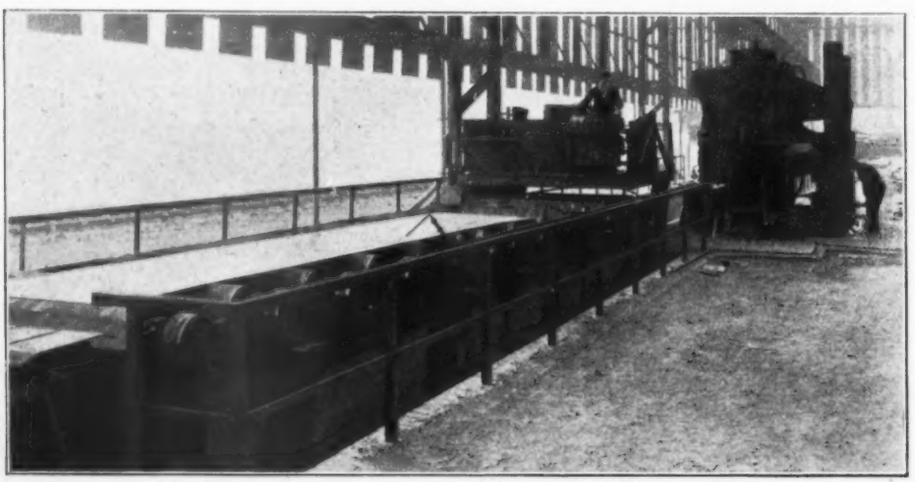

Fig. 3.—Clydebridge Works of David Colville & Sons, Limited. Hydraulic Side-cutting Shears, with Mechanical Manipulating Table.

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5. To improve machinability by eliminating hard spots and chilled corners and edges.
6. To secure maximum strength in machinable castings.
7. To reduce internal shrinkage and improve pressure tightness.

IT IS BELIEVED that similar advantages will follow scientific additions to British Cast Irons, and extensive research is at present in progress in this country upon this subject. We propose to keep ironfounders and all who are interested, fully advised of such results as are made public.

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Trade Talk.

The Steel Company of Scotland, Limited, have removed their head office from 23, Royal Exchange Square, Glasgow, to 37, Renfield Street, Glasgow.

The imports of foreign iron ore at the Senhouse Dock, Maryport, for the third quarter of the year amounted to 19,500 tons, compared with 22,900 tons for the previous three months.

Under the title of "The Belgian Manufacturers' Corporation," a co-operative company has recently been formed with a capital of 675,000 frs. (under £4,000) for the purpose of setting up a bureau in Bombay for selling Belgian products.

Messrs. W. R. Sefton-Fiddian and H. H. Leage, engineers and manufacturers, Bush Lane House, Bush Lane, Cannon Street, London, E.C., and 31, Park Road, Moseley, Birmingham, trading under the style of Sefton-Fiddian, Leage & Company, have dissolved partnership

The Northumberland Shipbuilding Company (1927), Limited, which reopened the Howdon Shipyard recently, has booked another order for a 9,000-ton cargo vessel for Cardiff owners. The vessel is to be engined by the North-Eastern Marine Engineering Company, Limited, Wallsend.

Two furnaces may shortly be restarted at Middlesbrough. The plant at the Ayresome Ironworks of Gjers, Mills & Company, Limited, has been idle for the past four months, but the firm contemplate the rekindling, within the next few weeks, of a hematite furnace and a furnace to produce ferro-silicon.

The Wolstanton Urban District Council have accepted the tender of Newton, Chambers & Company, Limited, for a new gasholder, with a capacity of 500,000 cub. ft., for £14,962. The tender of R. & J. Dempster, Limited, for the extension of purifiers, at a cost of £3,076, has also been accepted.

A new central battery telephone exchange was brought into service at Govan (Glasgow) on Saturday, September 17. The new switchboard, which was made and installed by Siemens Brothers & Company, Limited, of Woolwich, has thirteen operators' positions and is equipped for 700 subscribers, with an ultimate capacity of 2,000.

The grinding and pulverising offices of International Combustion, Limited, 11, Southampton Row, W.C.1, report that orders have recently been received for one Hardinge ball mill, one Hum-mer electric screen, and one Hardinge air classifying unit for England, and seven Hardinge mills, one Andrews' classifier, and seven Raymond mills for abroad.

The Barronia Metals Company, Limited, 47, Victoria Street, London, S.W.1, write that owing to the expiration of the lease on the above offices, and pending the completion of a reorganisation consequent upon the development of the business, all correspondence and office matters will for the time being be handled at the works, 59, Parsons Green Lane, Fulham, S.W.6.

Murdoch and Murray, Limited, shipbuilders, Port Glasgow, officially intimate that they have ceased to build ships. The firm, which was established in 1874, specialised for many years in vessels for service on South American rivers and in coasters and light-draught steamers. They had four building berths capable of taking ships up to 350 ft. in length, and the works were thoroughly well equipped.

The report has been issued of the preliminary inquiry, under the Boiler Explosions Acts, 1882 and 1890, into the causes of an explosion from a cast-iron steam stop-valve chest at the Lanarkshire Steelworks, Flemington, Motherwell. The observations of the engineer surveyor-in-chief to the Board of Trade are to the effect that the practice of fitting jointing material only within the bolt circle in the case of steam-pipe joints is not good practice, as it is liable to result in the adjacent necks of valve chests and pipe ends being stressed more severely than is desirable, especially where cast-iron is the material used for these parts. It is satisfactory that steel valve chests are now being fitted at these works when renewals are made.

An issue is being made to-day of 250,000 six-and-a-half per cent. cumulative preference shares of £1 each at par (free of income-tax up to 4s. in the £) of Charles Roberts & Company (1927), Limited. The authorised capital of the company consists of 250,000 preference shares and an equal number of ordinary shares of £1 each, and of the latter 219,400 have been allotted in part payment of the purchase price, of which the balance consists of £225,000 in cash. There are also £119,937 in terminable debentures. The amount required to pay the dividend on the preference shares is £20,313, and on the average earnings for the past six years this dividend was covered over four times, while the preference shares are covered more than twice over by assets, excluding goodwill

Sir William Reardon Smith, chairman of the St. Just, Leeds and other Cardiff shipping companies, has contracted for a Diesel motor vessel of 8,600 tons deadweight, to be built by William Doxford & Sons, Limited, Sunderland. Evan Thomas Radcliffe & Company, Cardiff, have contracted for two additional cargo steamers of about 8,250 tons deadweight, with Bartram & Sons, Limited, Sunderland. This firm contracted previously with the same builders for two steamers of 8,500 tons each, and also for two similar vessels with R. & W. Hawthorn, Leslie & Company, Limited.

Crompton Parkinson, Limited, report considerable increase of export business of late. Orders have been secured in India for the equipment of the Allahabad Power Station with two rotary converters, 6-phase, reversible, each of 400 kw., also one of 200 kw., together with the necessary starting equipment. Large orders have also been received from New South Wales for turbo-alternators, four oil engine-driven alternators. Five large auto-synchronous motors are also being supplied for pump drives for the Bunnerong Power Station, New South Wales. An order is now in hand for 19 125-h.p., 245-r.p.m., and 19 80-h.p. pipe-ventilated slip-ring motors. Johannesburg is responsible for three drip-proof auto-synchronous machines. Two drip-proof motors of 105 h.p. 415 volt, 50 cycle, 3-phase are being supplied for Southern Malayan Tin Dredging, Limited. These are duplicates of others already supplied. An extension of the equipment of the Egyptian Sugar Refining Company at Alexandria, consisting of three 175-kw. C.C. generators, is now in hand. Orders have also been received for auto-synchronous motors for Singapore, Perth, Western Australia, New Zealand, and Vishnu.

On the invitation of the Director of the Federation of British Industries, a private meeting of the Directors of Industrial Federations in Belgium, Czecho-Slovakia, France, Germany, Holland, Italy, Sweden and Switzerland was held in London on October 3 and 4. The Director of the Austrian Federation was prevented at the last moment from coming. The meeting discussed current questions which are occupying the attention of the various European Industrial Federations at the moment, and, in particular, gave its attention to the method whereby the Industrial Federations could co-operate in support of the resolutions of the World Economic Conference and of the Stockholm Congress of the International Chambers of Commerce, upon such questions as Customs nomenclature, double taxation, import and export restrictions, and the preparation of industrial statistics. A further exchange of views took place as to the forms of organisation taken by the Industrial Federations in the various countries. The discussions were of a useful character, as tending to indicate methods whereby European industrial organisations could improve the present method of interchanging views upon current economic questions of common interest.

Mr. P. W. Lee, managing director of Arthur Lee & Sons, Limited, was last week installed as Master Cutler of Sheffield. Speaking of the difficulties with which the steel trade is faced, he said that our production was only about two-thirds of our capacity. Our imports were increasing, and during the first half of the year we imported 2,570,000 tons. The value of that imported steel was nearly £20,000,000, and, assuming that 80 per cent. represented wages, there had been a loss in that respect of nearly £16,000,000, which, at £150 a year, represented work for 210,000 men for six months. Instead of working, these men had to be kept in idleness or on the "dole." Even at a low estimate, that would cost £40 a man for six months, or £8,400,000 for the 210,000 men. If the difference between British and foreign steel prices was 30s. a ton, that would represent a saving of £3,855,000. The net result of the transaction, therefore, was to save £3,855,000, and to spend £8,400,000—a loss of £4,545,000. If our works had made those 2,570,000 tons of steel, by how much we should have been able to reduce our selling prices, and yet make a profit, without which the trade must eventually perish! He was not preaching the safeguarding of industries, but was merely trying to place the position of the steel trade in an impartial light. The Government said that they would not take any action to safeguard the steel industry for political reasons. So long as the Government could get their revenue fairly easily from merchants, shopkeepers, and bankers, they did not regard the interests of the actual producers of wealth—the farmer, the miner, and the manufacturer. Nothing would be done by any Government until the people themselves demanded that some action should be taken to safeguard our basic industries. It was not a matter for politics, but for an industrial and financial commission to inquire into all the facts, and see whether free imports, safe-guarding of industries, or tariff reform was best for the country as a whole.

Obituary.

Mr. Joseph Starkey, who for many years carried on the business of a lock manufacturer at Willenhall, died last week.

After several months illness, the death has occurred at Tettenhall, Wolverhampton, of Mr. C. A. Frantz, for twenty years managing director of Pinson & Evans, Limited, galvanisers, of Dudley Road, Wolverhampton.

Mr. Wm. Satterthwaite, whose death occurred with remarkable suddenness at Manchester last week, while waiting for a train, was, for a lengthy period before his retirement, underground manager of the Millom & Askam Company's Ullcoats iron ore mine. He was 76 years of age.

Personal.

Mr. M. L. Becker, who has for several years been carrying on research work for the B.C.I.R.A. at Manchester University under the general direction of Professor F. C. Thompson, has joined the metallurgical staff of the National Physical Laboratory, Teddington, Middlesex.

Mr. J. Lloyd Bentley, who has been with Dorman, Long & Company, Limited, for the last seven years, has been appointed works manager in general charge of the iron and steel works in Staffordshire of Robert Heath & Low Moor, Limited.

Sir C. E. Low has been appointed to take charge of the Indian organisation of Agricultural and General Engineers, Limited, with offices in Calcutta, and Major G. Fetherston to take charge of the South African engineering organisation, with offices in Johannesburg.

Mr. W. Jennings, of Dudley, who quite recently retired from the position of roll designer and turner after 45 years' service at the Old Hill Ironworks of N. Hingley & Sons, Limited, has been the recipient of presentations from the directors, workpeople and staff.

Mr. P. J. Pybus has resigned the position of chairman of the English Electric Company, Limited, in order to undertake further public work. He will, however, retain his seat on the board of the company and will continue to represent it on various associated companies. Mr. W. L. Hichens has been elected chairman, while Sir Charles Ellis will continue to act as deputy chairman.

Mr. John Shaw, who recently retired from, but is retained as a consultant by, the Brightside Foundry and Engineering Company, Limited, of Sheffield, is now permanently settled at Cartref, Parkstone Avenue, Southsea. As Mr. Shaw is still actively concerned with the establishment of both national and international test bars for cast-iron, the various interests should carefully note it.

Sir James Marr, who has been for fifty years connected with the shipbuilding firm of J. L. Thompson & Sons, Limited, of Sunderland, and who for forty years has been chairman of the Sunderland Forge and Engineering Company, Limited, was, to mark the occasion, on September 29, presented by the officials and workpeople of the latter firm, with a cheque and a silver salver. Sir James has handed the cheque to the local hospital, in which he takes keen interest.

Wills.

Maclaren, J. J. S., chairman of the Carron Company, Limited	£433,090
Cook, S. F., mining engineers, of Lyndhurst Road, Exmouth	£9,097
Macfarlane, A., formerly managing director of the Middle Docks and Engineering Company, Limited, South Shields	£14,804
MacIver, C., of Blaisdon Hall, Longhope, Glos., a director of Peter Stubs, Limited, file manufacturers, of Warrington	£24,469
Hills, Arnold F., of Hammerfield, Penshurst, Kent, formerly head of the Thames Ironworks and Shipbuilding Company	£60,496
Maclaren, James Joseph Stainton, of Ratho Park, Ratho, Midlothian, for many years chairman of the Carran Company, who died on May 24, aged 85	£433,090
Sperring, Bertram Ford, of Lake Road, Landport, Portsmouth, of William Henry Sperring & Company, Limited, Albion Works, Landport, who died on May 20, aged 54	£9,003

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Iron and Steel Markets.

Pig-iron.

MIDDLESBROUGH.—Although not yet quite fully restored to anything like normal conditions of production, the outlook for the Cleveland iron trade is distinctly more promising than has been experienced for a long time past, a prospect that also infers an expanding demand in the industry more intimately associated with this journal, as well as other important outlets for consumption. Confirmation of these views is provided by the decision of the well-known Tees-side firm of Messrs. Gjers, Mills & Company to restart the Ayresome Ironworks shortly, the plant having been closed down at the end of May owing to a heavy accumulation of stock, which has now been completely liquidated, thus bringing the number of furnaces in blast on the North-East Coast to a total of 41. It is not regarded as improbable that further inoperative blast furnaces will shortly be restarted, as business in Cleveland iron continues on a scale definitely in excess of production. In addition to this gratifying, if gradual, increase in home demand, export business is also moving in that direction, the pig-iron shipments having totalled 14,884 tons during September, 6,878 tons going coastwise and 8,006 tons abroad. It is further satisfactory to note that Scottish contracts for foreign pig are now completed, most of the buying for that area being placed with Cleveland makers. Subject to the usual discounts, quotations for Cleveland iron continue unchanged as follow:—No. 1 foundry iron, 70s.; No. 3 G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d.; No. 4 forge, 66s. per ton.

The Tees-side hematite market, though slower in recovery than that for foundry pig, is still making progress in the export section, and considerable shipments are being booked for Continental delivery at reduced prices. Thus mixed numbers of East Coast hematite are now freely offered at 74s. per ton, f.o.t. or f.o.b., and 73s. per ton has in some cases been accepted, with 6d. per ton premium for No. 1 quality. On the North-West Coast similar weakness is in evidence, Bessemer mixed numbers being now quoted at 73s. to 74s. per ton at works, and low-phosphorus iron is in fair request at 5s. per ton above this figure.

LANCASHIRE.—Autumn buying of foundry pig in the local markets is reported to be on a fairly satisfactory scale, consumers having reached the conclusion that little can be gained by further postponing purchases. Business has been recently done in Derbyshire No. 3 at 74s. per ton delivered Manchester or equal, while Staffordshire makers have not so far abandoned their 73s. 9d. basis. Makers of Cleveland iron continue to quote for delivery in Lancashire at 80s. 8d. per ton, whilst Scottish is offered at from 90s. to 91s.

THE MIDLANDS.—Consumers in this area still maintain caution in their purchases, the bulk of the business reported being of limited tonnage for prompt delivery. There have been, however, a few instances of forward buying for delivery over the next three months. Northants No. 3 is quite steady in the region of 60s., and Derbyshire and North Staffordshire at 65s. per ton for No. 3, f.o.t. furnaces.

SCOTLAND.—Prices for Scotch pig-iron continue steady on the basis of 73s. 6d. for No. 3 foundry at furnaces, and a few consumers who happen to be better placed with work than others are inclined to buy ahead. A moderate business has been done on these lines, but the majority of consumers continue to purchase on a hand-to-mouth basis.

Finished Iron.

Competition, both home and foreign, is still keenly in evidence in the markets for bar iron for what business is now available. The makers outside Staffordshire are competing very strongly and are taking very low figures for crown quality, the prices varying from £9 10s. to £9 17s. 6d. per ton for good lines, and some of the Staffordshire works are having to meet this competition, although for small quantities £10 to £10 5s. is quoted. Nut and bolt iron, for which there is scarcely any demand from local mills, is offered at £9 per ton. The nut and bolt makers in the Darlaston district are very quiet, and orders to the Continent for their iron have fallen off to a considerable extent. Marked bars have been reduced to £13 at makers' works. The makers of this iron are not so badly off for work as producers of the cheaper brands, but even they are not without anxiety, and have anything but good order books.

Steel.

At Sheffield the steel market is reported slightly more active, with a fair volume of business passing in semi-products. Basic billets are selling more freely than acid qualities, but are still subject to sharp Continental competition. There are no price changes to record. The call for open-hearth steel is somewhat smaller, but production is still on a large scale. The output of special and electric steel is expanding, but crucible steel demand shows a shrinkage. Business in tinplates remains in a depressed condition, without signs of improvement in the near future, and the outlook at present is far from favourable to an early revival.

Scrap.

The improvement in the iron and steel markets noted of late has not yet extended to corresponding movements in scrap metals, and general reports indicate little change for the better in the volume of business transacted. On the North-East Coast the foundries are only moderately employed, but offer no more than 61s. per ton for ordinary heavy cast iron, whilst heavy machinery quality in handy pieces realises 65s. per ton. In Scotland machinery cast-iron scrap is still a drug on the market, and there is difficulty in finding buyers or outlets for this material, with the result that the price is now down as low as 67s. 6d. to 68s. 6d. for material suitable for foundries, and in pieces not exceeding 1 cwt. Ordinary heavy cast-iron scrap to the same specification is being quoted around 62s. to 63s. 6d. per ton, old cast-iron chairs at 67s. 6d. per ton, and light cast iron around 57s. 6d. per ton. These prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—Though closing last week slightly above the worst, the usual tendency of the market for warrant copper now coincides more nearly with the depressed conditions of other sections of base metals, with values again below the average ruling at an earlier period in the month. Generally speaking, consumers appear to be very reluctant to increase their commitments, and there are doubts as to whether activity will be maintained on even its present scale throughout the last quarter of the year.

Official closing prices of standard copper have been as follow:—

Cash: Thursday, £53 15s. to £53 17s. 6d.; Friday, £53 16s. 3d. to £53 17s. 6d.; Monday, £54 1s. 3d. to £54 2s. 6d.; Tuesday, £54 7s. 6d. to £54 8s. 9d.; Wednesday, £54 15s. to £54 16s. 3d.

Three Months: Thursday, £54 to £54 1s. 3d.; Friday, £54 1s. 3d. to £54 2s. 6d.; Monday, £54 6s. 3d. to £54 7s. 6d.; Tuesday, £54 11s. 3d. to £54 12s. 6d.; Wednesday, £54 18s. 9d. to £55.

Tin.—Values of standard tin continue on the weaker basis for cash noted in previous reports, and the general tone of the market at the moment tends distinctly to pessimistic views as to the prospect of an early improvement in the position. As generally anticipated, the visible supply of tin at the end of September showed a rather substantial increase on the figures ruling at the end of August. Despite the increase in supplies, it was extraordinary to note that the price of tin rallied at times for spot. This movement is merely a reflection of the heavy set-back which has been seen of late, and is not trusted in metal market circles. It is possible that the end of October will see very little change in the actual supply of the metal, but in succeeding months there is every probability of augmented supplies which may overtake the consumptive demand.

Official closing prices of standard tin have been as under:—

Cash: Thursday, £264 10s. to £264 15s.; Friday, £266 15s. to £266 17s. 6d.; Monday, £266 5s. to £266 10s.; Tuesday, £262 5s. to £262 10s.; Wednesday, £261 15s. to £262.

Three Months: Thursday, £262 to £262 5s.; Friday, £264 to £264 2s. 6d.; Monday, £264 2s. 6d. to £264 7s. 6d.; Tuesday, £260 to £260 5s.; Wednesday, £259 12s. 6d. to £259 17s. 6d.

Spelter.—An inactive demand for ordinary spelter has resulted in further weakening of values, which have lost several shillings lately. New business is not very conspicuous, but deliveries under contract are going on fairly well. The demand from galvanisers is rather poor, many of the works being themselves badly in need of orders, and practically the only business doing at the moment is on a rather small scale for very close delivery.

The following are the week's prices:—

Ordinary: Thursday, £26 8s. 9d.; Friday, £26 10s.; Monday, £26 16s. 3d.; Tuesday, £27 1s. 3d.; Wednesday, £27 7s. 6d.

Lead.—The market for soft foreign pig continues on the down grade, although during the past week occasional heavy buying somewhat relieved the depression. At one time business was particularly active, well over 1,000 tons being taken by prominent operators in a very short period, but even this failed to stay the prevailing weakness, which became rather acute.

The week's prices are appended:—

Soft foreign (prompt): Thursday, £20 2s. 6d.; Friday, £20 2s. 6d.; Monday, £20 3s. 9d.; Tuesday, £20 3s. 9d.; Wednesday, £20 10s.

New Companies.

F. C. Booth & Company, Limited.—Capital £2,000 in £1 shares, to acquire business of tinplate manufacturer carried on at 16-22, Camden Street, Birmingham, by R. Lewis. Directors: R. Lewis and A. C. Harris.

Joseph Booth & Bros., Limited.—Capital £45,000 in £1 shares, to acquire business of manufacturers of cranes, electric trucks and contractors' plant, etc., carried on at Union Foundry and Iron Works, Rodley, Leeds, by Joseph Booth & Bros. (in voluntary liquidation). Director: G. Baker.

Central Power Engineering Company, Limited.—Capital £3,000. Business at Wardrobe Court, 146a, Queen Victoria Street, E.C. Directors: A. J. Gregory (permanent) and A. L. Hodges.

Electrical Enterprise, Limited, 13, Victoria Street, Westminster, S.W.1.—Capital £30,000 (15,000 preference and 15,000 ordinary), to acquire the Bungay Gas Works, the electricity undertaking operating in conjunction therewith, and the Burnham-on-Crouch and District Electricity Special Order, 1927. Directors: J. A. Purves, Laura A. Willson, A. R. C. Johnston, Mary M. Partridge, Caroline H. Haslett (secretary of the Women's Engineering Society, and J. N. A. Houblon.

Richard France, Limited.—Capital £3,000 in £1 shares, to take over business of brass and aluminium founder carried on at Leicester Place, Monument Street, Peterborough, by R. France. Directors: R. France, J. P. Bristow, H. Clemenson, F. Hulland and C. Steers.

Holinter, Limited, 339-340, Dashwood House, Old Broad Street, E.C.2.—Capital £5,000 in £1 shares, to acquire the business of N. V. Hollandsche en Internationale Handelsmaatschappij at 339-340, Dashwood House, Old Broad Street, E.C. General merchants, buyers and sellers of railway, shipping and other plant, etc. Directors: O. Mayer, G. Hamilton, F. H. Gamburg and A. Rothschild.

John Hickman & Sons, Limited.—Capital £1,000 in £1 shares, to acquire from F. J. Hickman, W. J. Hickman and T. W. Jordan business carried on by them as John Hickman & Son, at Bilston, as ironfounders, etc.

Kiblock (Patents), Limited, 52, Bedford Square, W.C.1.—Capital £9,000, to acquire patents and rights for manufacture of standard nut with locking device, etc. Directors: K. Fisher (chairman), J. G. de Jetley-Marks, S. L. Spalding, S. T. Spalding, T. H. McArthur and W. E. Cook.

Lamberton & Company, Limited, Sunnyside Engine Works, Coatbridge.—Capital £50,000 in £1 shares, to acquire business of Lamberton & Company, engineers and ironfounders, Sunnyside Engine Works, Coatbridge. Directors: A. Lamberton, J. R. Lamberton and J. C. Hendry.

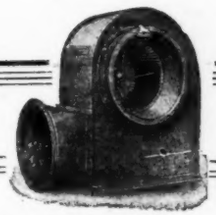
Rallik, Limited.—Capital £6,500 in 5,000 7½ per cent. cumulative participating preference shares of £1, and 30,000 ordinary shares of 1s. Metal merchants.

Stenner & Gunn, Limited, Lowman Iron Works, Lowman Green, Tiverton, Devon.—Capital £5,000 in £1 shares. Engineers.

Swansea Residues, Limited, 49, Mincing Lane, E.C.2.—Capital £35,000 in £1 shares. Ore refiners.

Willis and Bates, Limited, "Pelican Works," Spring Hall Lane, Halifax.—Capital £20,000 in £1 shares (10,000 6 per cent. preference). Metal spinners and stampers, etc. Directors: A. Bates (chairman and managing director), C. C. Willis and S. W. Bates (all permanent).

Kirk Wilson, Limited.—Capital £6,000 in £1 shares (2,000 7 per cent. cumulative preference and 4,000 ordinary). Engineers.



40 Years' Experience in the Design and Construction of Fans

for

Heating and Ventilation of Buildings, Mines and Ships,
High Pressure Blast for Forges, Furnaces and Cupolas,
Mechanical Boiler Draught,
Fume and Steam Removal,
Dust Removal and Collection,
Cooling and Drying Plants.

means

Expert Knowledge, High Efficiency, Reliability and Good Service

Davidson's the TRADE SIROCCO MARK Fan Makers

have an experience covering hundreds of different industries and hundreds of different uses, and they can furnish a Sirocco Fan for every purpose for which a fan can be employed.

Solve your fan problems by using the Sirocco Service.

DAVIDSON & Co. LIMITED

SIROCCO ENGINEERING WORKS - BELFAST

London - Birmingham - Cardiff - Bristol Manchester - Glasgow - Newcastle

PIG IRON and High Grade CYLINDER IRON

For Motor Castings.

FOUNDRY & FURNACE COKE

J. C. ABBOTT & Co LTD

Lloyd's Bank Chambers, New Street, BIRMINGHAM.
Telephone. MIDLAND 170.

WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	54 15 0
Three months	54 18 9
Electrolytic	62 5 0
Tough	59 15 0
Best selected	60 15 0
Sheets	86 0 0
India	71 0 0
Wire bars	62 15 0
Do. October	62 5 0
Do. November	62 5 0
Ingot bars	62 5 0
H.C. Wire rods	67 0 0
Off. av. cash, Sept.	54 9 9 3/11
Do. 3 mths., Sept.	54 19 0 9/11
Do., Sttlmnt., Sept.	54 9 9 3/11
Do., Electro, Sept.	62 0 2 8/11
Do., B.S., Sept.	60 11 11½
Aver. spot price, copper, Sept.	54 9 9½
Do., Wire bars, Sept.	62 3 10½
Solid drawn tubes	12½d.
Brazed tubes	12½d.
Wire	9½d.

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	10⅝d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	9½d.
Wire	9⅜d.
Rolled metal	9½d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£ s. d.
Standard cash	261 15 0
Three months	259 12 6
English	261 5 0
Bars	264 0 0
Straits	269 0 0
Australian	267 10 0
Eastern	266 15 0
Banca	273 10 0
Off. av. cash, Sept.	280 10 10 5/22
Do., 3 mths., Sept.	276 6 2 7/22
Do., Sttlmt., Sept.	280 10 5 5/11
Aver. spot, Sept.	280 10 10¼

SPELTER.

Ordinary	27 7 6
Remelted	25 10 0
Hard	21 5 0
Electro 99.9	30 15 0
English	27 10 0
India	23 5 0
Zinc dust	35 0 0
Zinc ashes	8 15 0
Off. aver., Sept.	27 6 8 11/44
Aver., spot, Sept.	27 6 11⅝

LEAD.

Soft foreign ppt.	20 10 0
English	21 15 0
Off. average, Sept.	21 14 4 37/44
Average spot, Sept.	21 8 11

ZINC SHEETS, &c.

Zinc sheets, English	36 0 0
Do. V.M. ex whf.	34 10 0
Rods	42 0 0
Boiler plates	34 0 0
Battery plates	33 10 0

ANTIMONY.

Special brands, Eng.	64 10 0
Chinese	45 0 0
Crude	38 0 0

QUICKSILVER.

Quicksilver	22 10 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	8 17 6
45/50%	12 15 6
75%	20 5 0
Ferro-vanadium—	
35/40%	14/3 lb. va.
Ferro-molybdenum—	
70/75% c. free	5/- lb.
Ferro-titanium—	
23/25% carbonless	11½d.
Ferro-phosphorus, 20/25%	£17 15 0
Ferro-tungsten—	
80/85%, c. fr.	1/3 lb.
Tungsten metal powder—	
98/99%	1/8½ lb.
Ferro-chrome—	
2/4% car.	£33 0 0
4/6% car.	£23 0 0
6/8% car.	£22 15 0
8/10% car.	£22 10 0
Ferro-chrome—	
Max. 2% car.	£36 0 0
Max. 1% car	£41 10 0
Max. 0.70% car	£53 0 0
70% carbonless	1/4 lb.
Nickel—99%, cubes or pellets	£170 0 0
Ferro-cobalt	9/3 lb.
Aluminium 98/99%	£105 0 0
Metallic chromium—	
96/98%	3/- lb.
Ferro-manganese (net)—	
76/80%, loose	£13 0 0
76/80%, packed	£14 0 0
76/80%, export	£11 15 0
Metallic manganese—	
94/96%, carbonless	1/10 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 6
Finished bars, 18% tungsten	£0 3 0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 5/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/-lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

Scrap from high-speed tool steel—

Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£ s. d.
South Wales—	
Hvy. steel	2 17 6
Bundled steel and shrngs.	2 12 6
Mixed iron and steel	2 11 0 to 2 12 6
Heavy cast iron	2 17 6
Good machinery for foundries	3 0 0
Cleveland—	
Heavy steel	2 17 6
Steel turnings	2 5 0
Cast iron borings	2 2 6
Heavy forge	3 12 6
Bushelled scrap	3 2 6
Cast-iron scrap	3 1 0 to 3 5 0
Lancashire—	
Cast-iron scrap	3 5 0
Hvy. wrought	3 2 6
Steel turnings	2 2 6

London—Merchants' buying prices delivered yard.

Copper (clean)	48 0 0
Brass (clean)	37 0 0
Lead (less usual draft)	18 10 0
Tea lead	16 0 0
Zinc	16 10 0
New aluminium cuttings	76 0 0
Braziery copper	45 0 0
Gunmetal	46 0 0
Hollow pewter	170 0 0
Shaped black pewter	130 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	70/-
Foundry No. 3	67/6
Foundry No. 4	66/6
Forge No. 4	66/-
Hematite No. 1	74/6
Hematite M/Nos.	74/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	83/6
,, d/d Birm.	92/6
Midlands—	
Staffs. common*	—
,, No. 4 forge	59/9
,, No. 3 fdry.	65/-
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	54/-
,, fdry. No. 3	60/-
Derbyshire forge	60/-
,, fdry. No. 3	65/-
,, basic	—
Scotland—	
Foundry No. 1	—
,, No. 3	73/6
Hem. M/Nos.	76/-
Sheffield (d/d district)—	
Derby forge	66/-
,, fdry. No. 3	68/-
Lincs. forge	—
,, fdry. No. 3	68/-
E.C. hematite	85/-
W.C. hematite	90/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	73/-
Northants foundry No. 3	—
Dalzell, No. 3	105/- to 107/6
Summerlee, No. 3	91/- to 100/-
Glengarnock, No. 3	91/- to 100/-
Gartsherrie, No. 3	91/- to 100/-
Monkland, No. 3	91/- to 100/-
Coltness, No. 3	91/- to 100/-
Shotts, No. 3	91/- to 100/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron ; delivered consumers' station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.) nom.	9 15 0 to	10 15 0
Angles	—	
Tees to 3 united ins.	—	
Nut and bolt iron	—	
Hoops	14 10 0	
Marked bars (Staffs.) f.o.t.	13 0 0	
Gas strip	12 10 0	
Bolts and nuts, ¾ in. × 4 in.	15 5 0	
Steel—		
Ship plates	8 2 6	
Boiler plts.	10 10 0	
Chequer plts.	10 5 0	
Angles	7 12 6	
Tees	8 12 6	
Joists	7 12 6	
Rounds and squares, 3 in. to 5½ in.	7 15 0	
Rounds under 3 in. to ¾ in. (Untested)	8 0 0 and upwards	
Flats, over 5 in. wide and up	9 2 6	
Flats, 5 in. to 1½ in.	8 2 6	
Rails, heavy	8 2 6	
Fishplates	12 10 0	
Hoops (Staffs.)	10 10 0	
Black sheets, 24g.	10 12 6	
Galv. cor. shts., 24g.	13 17 6	
Galv. fencing wire 8g. plain	12 10 0	
Billets, soft	£5 15 0 to 7 0 0	
Billets, hard	8 2 6	
Sheet bars	£5 12 6 to 5 15 0	
Tin bars	£5 12 6 to 5 15 0	

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 2¼
Sheet to 10 w.g.	1 2½
Wire	1 3¼
Rods	1 2¼
Tubes	1 8
Castings	1 2

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	20.26
No. 2 foundry, Valley	17.50
No. 2 foundry, Birm.	17.25
Basic	20.00
Bessemer	19.76
Malleable	19.26
Grey forge	18.76
Ferro-mang. 80% d/d	90.00
Bess rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	34.00
Wire rods	43.00
	Cents.
Iron bars, Phila.	2.07
Steel bars	1.75
Tank plates	1.75
Beams, etc.	1.75
Skelp, grooved steel	1.75
Skelp, sheared steel	1.75
Steel hoops	2.30
Sheets, black, No. 24	3.00
Sheets, galv., No. 24	3.85
Sheets, blue an'l'd., 9 and 10	2.25
Wire nails	2.55
Plain wire	2.40
Barbed wire, galv.	3.25
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham and North.	
,, foundry	—
,, furnace	14/-
Other Districts, foundry	—
,, ,, furnace (basis)	12/-

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14	box	18/3
,,	28×20	,,	36/6
,,	20×10	,,	—
,,	18¾×14	,,	—
C.W.	20×14	,,	17/3
,,	28×20	,,	—
,,	20×10	,,	—
,,	18¾×14	,,	—
Terneplates	28×20	—	per box basis f.o.b.

SWEDISH IRON.

Bars, hammered,	£18 10 0 to 19 0 0
Rolled Ord.	£15 0 0 to £15 10 0
Nail rods	£15 7 6 to £15 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron	£5 15 0 to £6 0 0

all f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	Fittings.
Gas	67½%	.. 45%
Water	63¾%	.. 40%
Steam	60%	.. 35%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£ s. d.	
Oct. 6 ..	53 15 0	dec. 5/-
,, 7 ..	53 16 3	inc. 1/3
,, 10 ..	54 1 3	,, 5/-
,, 11 ..	54 7 6	,, 6/3
,, 12 ..	54 15 0	,, 7/6

Electrolytic Copper.

		£ s. d.	
Oct. 6 ..		61 15 0	No change
,, 7 ..		61 15 0	,, ,,
,, 10 ..		62 0 0	inc. 5/-
,, 11 ..		62 5 0	,, 5/-
,, 12 ..		62 5 0	No change

Standard Tin (cash).

	£ s. d.	
Oct. 6 ..	264 10 0	dec. 55/-
,, 7 ..	266 15 0	inc. 45/-
,, 10 ..	266 5 0	dec. 10/-
,, 11 ..	262 5 0	,, 80/-
,, 12 ..	261 15 0	,, 10/-

Tin (English ingots).

		£ s. d.	
Oct. 6 ..		263 10 0	dec. 55/-
,, 7 ..		265 15 0	inc. 45/-
,, 10 ..		265 5 0	dec. 10/-
,, 11 ..		262 0 0	,, 65/-
,, 12 ..		261 5 0	,, 15/-

Zinc Sheets (English).

	£ s. d.	
Oct. 6 ..	36 0 0	No change
,, 7 ..	36 0 0	,, ,,
,, 10 ..	36 0 0	,, ,,
,, 11 ..	36 0 0	,, ,,
,, 12 ..	36 0 0	,, ,,

Spelter (ordinary).

	£ s. d.	
Oct. 6 ..	26 8 9	No change
,, 7 ..	26 10 0	inc. 1/3
,, 10 ..	26 16 3	,, 6/3
,, 11 ..	27 1 3	,, 5/-
,, 12 ..	27 7 6	,, 6/3

Lead (English).

	£ s. d.	
Oct. 6 ..	21 10 0	dec. 5/-
,, 7 ..	21 10 0	No change
,, 10 ..	21 10 0	,, ,,
,, 11 ..	21 10 0	,, ,,
,, 12 ..	21 15 0	inc. 5/-

AVERAGE MONTHLY PRICES OF CLEVELAND No. 3 PIG-IRON.

Year.	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Yearly Average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1887	37 5	35 10	34 4	34 4	34 1	34 10	34 4	34 5	33 9	31 10	31 8	33 6	34 2
1888	32 2	31 1	31 5	31 9	30 11	31 5	32 4	33 5	34 8	34 2	33 11	33 10	32 7
1889	33 8	35 0	37 5	38 9	38 6	37 10	40 1	43 4	44 1	51 5	64 7	61 1	43 10
1890	60 3	53 1	51 0	47 4	42 2	41 5	43 2	45 7	47 9	47 10	47 4	43 1	47 6
1891	42 1	41 10	39 9	38 7	40 9	41 0	40 8	39 8	40 4	39 11	38 8	38 1	40 1
1892	37 7	35 7	36 10	37 10	39 2	40 11	39 11	39 10	40 0	38 6	37 6	37 4	38 5
1893	36 0	34 3	34 4	34 2	33 10	34 8	35 3	35 5	35 4	34 8	34 7	35 9	34 10
1894	35 8	35 11	36 1	36 1	35 5	35 5	35 5	35 11	36 6	35 8	35 8	35 1	35 9
1895	34 7	34 4	34 4	34 8	35 6	35 2	36 1	37 1	38 10	38 6	37 11	37 6	36 3
1896	37 3	38 4	38 7	38 1	37 4	37 4	36 11	36 11	37 11	39 2	40 5	40 5	38 3
1897	41 2	40 4	40 5	39 2	39 7	40 9	39 6	40 5	41 7	42 5	41 5	40 4	40 7
1898	40 9	40 8	40 6	40 0	40 7	39 11	40 4	41 11	43 0	44 11	49 1	44 3	42 0
1899	46 10	47 11	47 0	49 10	55 11	62 10	71 6	65 9	67 7	68 8	70 0	66 9	60 5
1900	67 10	68 10	73 10	76 2	74 2	68 6	69 3	71 4	70 9	67 8	63 6	53 6	68 9
1901	48 0	46 6	45 8	45 5	45 10	44 7	44 6	45 3	45 3	45 3	43 6	43 1	45 3
1902	43 11	46 7	46 9	47 11	48 10	49 7	50 9	52 1	53 6	52 9	50 9	47 11	49 3
1903	47 3	48 9	51 10	49 0	46 1	46 2	46 7	46 8	45 7	43 6	42 10	41 11	46 4
1904	42 3	42 7	43 3	44 7	44 0	42 10	42 9	43 3	43 1	43 9	46 1	48 7	43 11
1905	48 11	48 0	49 6	50 1	51 5	45 6	45 9	47 5	48 8	52 11	52 9	53 3	49 6
1906	53 9	50 1	48 1	48 8	50 2	50 3	50 6	53 0	54 6	56 8	58 6	62 4	53 6
1907	60 4	56 6	54 10	56 0	61 1	58 1	57 8	57 8	55 7	54 8	50 8	50 0	56 2
1908	48 5	49 3	51 7	51 10	51 6	51 2	50 0	51 4	52 0	49 8	49 4	48 11	50 8
1909	48 10	48 1	46 9	47 9	48 4	48 9	48 6	50 5	51 3	51 11	51 2	50 7	49 4
1910	51 10	51 3½	51 7½	50 10	49 10	49 2	48 10	49 8½	49 3½	49 7½	49 6½	49 10	50 4
1911	49 11½	49 2½	48 5	46 11	46 4	46 6	46 11½	47 4	47 0	46 7	47 4½	48 1	47 7
1912	50 0	49 5½	51 1½	53 7½	54 4	55 1	57 5½	64 6½	61 7½	66 8½	67 8	68 0	58 5½
1913	66 11½	63 8½	64 8	67 1½	66 3	56 9½	56 3½	55 8	55 4	53 0	50 1	50 4	58 10
1914	50 11	51 5½	51 0½	51 4½	51 6	51 6½	51 5	52 3	51 5	50 1	50 3	53 0	51 4½
1915	55 7	56 6	61 0	66 7	65 2	66 10	65 4	66 0½	65 3	65 11	69 10½	75 7½	65 7½
1916	80 2	91 6	87 4½	86 10	82 6	82 6	87 6	87 6	87 6	87 6	87 6	87 6	85 10
1917	87 6	87 6	87 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	95 0	91 3
1918	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0
1919	95 0	95 0	95 0	95 0	152 6	160 0	160 0	160 0	160 0	160 0	160 0	160 0	137 8
1920	175 0	175 0	187 6	200 0	208 0	217 6	217 6	221 0	225 0	225 0	225 0	225 0	209 3
1921	222 6	195 0	150 0	126 0	120 0	120 0	120 0	136 3	127 0	120 0	110 0	100 0	137 4
1922	92 6	90 0	90 0	90 0	90 0	90 0	89 0	87 3	92 6	92 6	92 6	91 3½	90 7½
1923	94 6	108 9	125 6	129 4½	128 5	136 0	128 1½	121 11	97 1½	97 0	100 0	100 0	110 6½
1924	99 10	97 3½	91 9	93 9	91 9	89 10½	87 9	85 0	82 5½	80 2½	81 9	81 9	88 7½
1925	80 4½	78 10½	78 0	78 3	76 0	73 10½	71 7½	69 10½	68 1½	66 7½	66 0	66 10½	72 10½
1926	69 4½	70 0	70 0	70 0	72 6	75 10½	86 7½	90 0	93 10½	117 10	120 0	99 0	86 3
1927	85 0	83 1½	81 0	80 0	73 9	70 0	70 0	68 9	67 6	—	—	—	—

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

18, BENNETTS HILL, BIRMINGHAM.
11, OLD HALL STREET, LIVERPOOL.
ROYAL BLDS., FISHER ST., SWANSEA.
FOWLERS BUILDINGS, BOMBAY.
CLIVE STREET, CALCUTTA.
20, SECOND LINE BEACH, MADRAS.
1, HONG KONG ROAD, SHANGHAI.

REGISTERED TRADE MARK

OCEAN BUILDING, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5, SHAFFRAZ ROAD, RANGOON
NADIR HOUSE, MACLEOD ROAD, KARACHI.
1 SHAREH SONK EL TEWFIKIEH, CAIRO.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.,

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD MIDDLESBROUGH

SMALL ADVERTISEMENTS.

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SITUATIONS VACANT AND WANTED.

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